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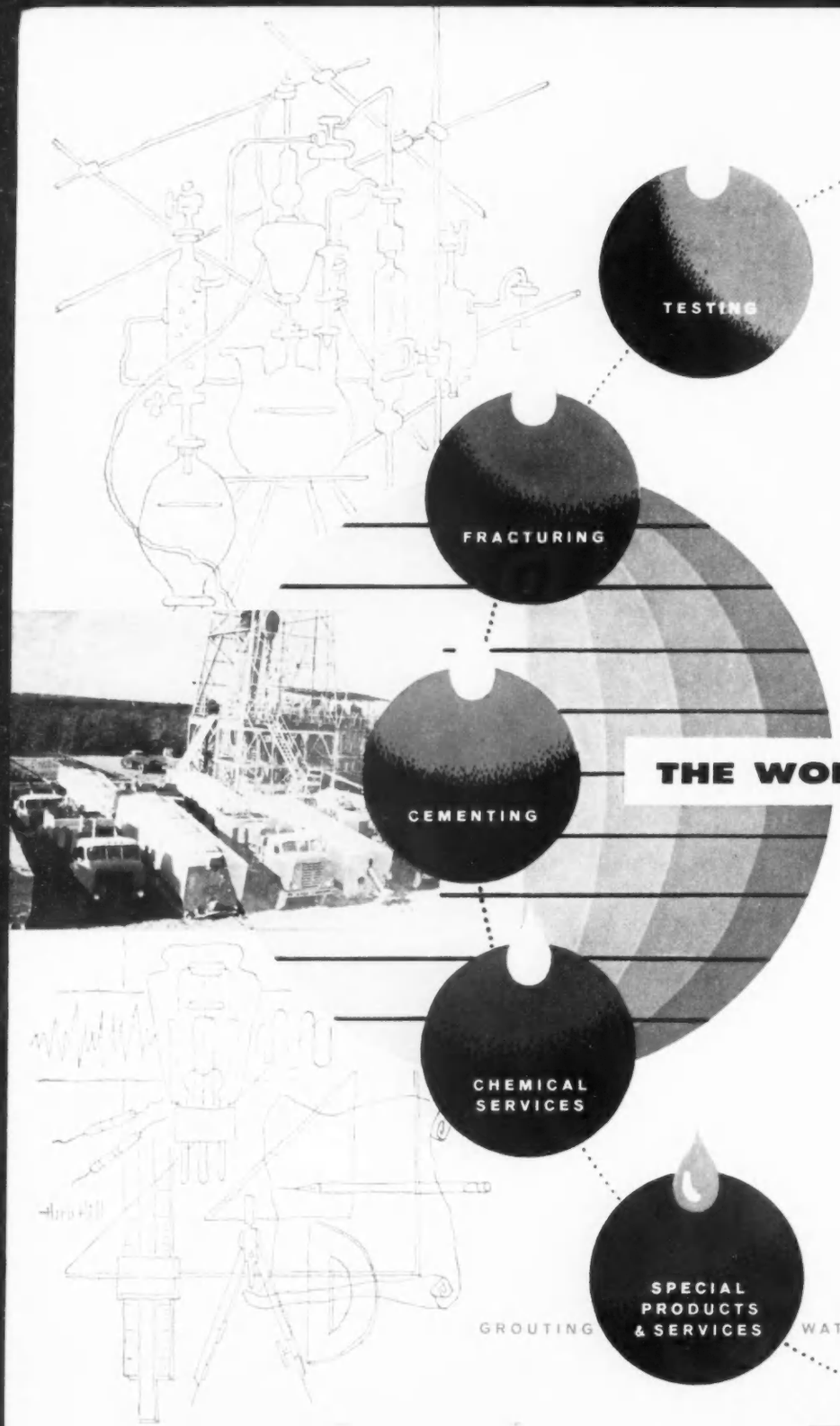

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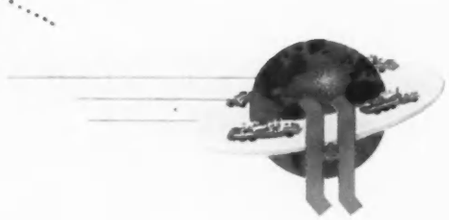

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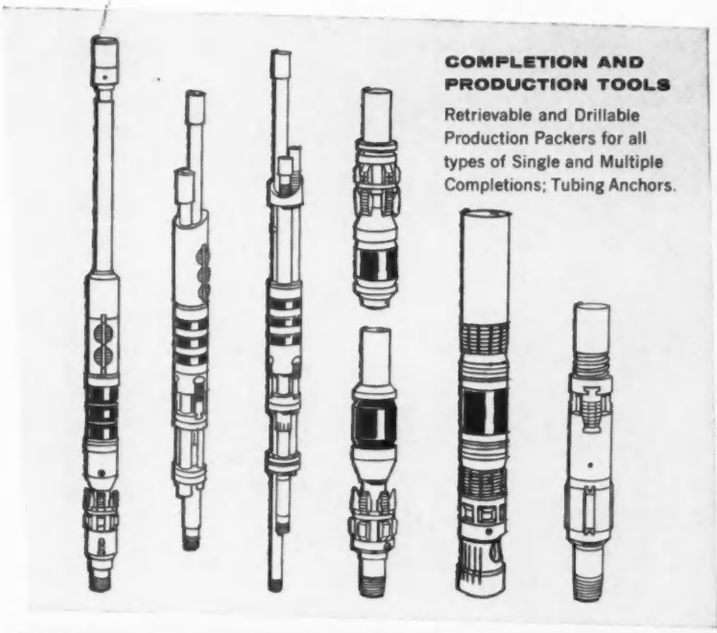

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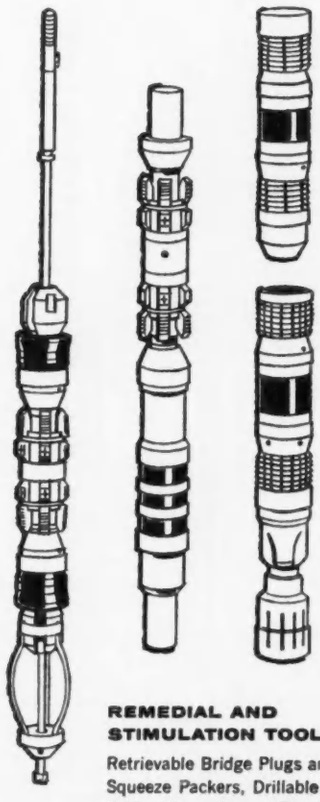

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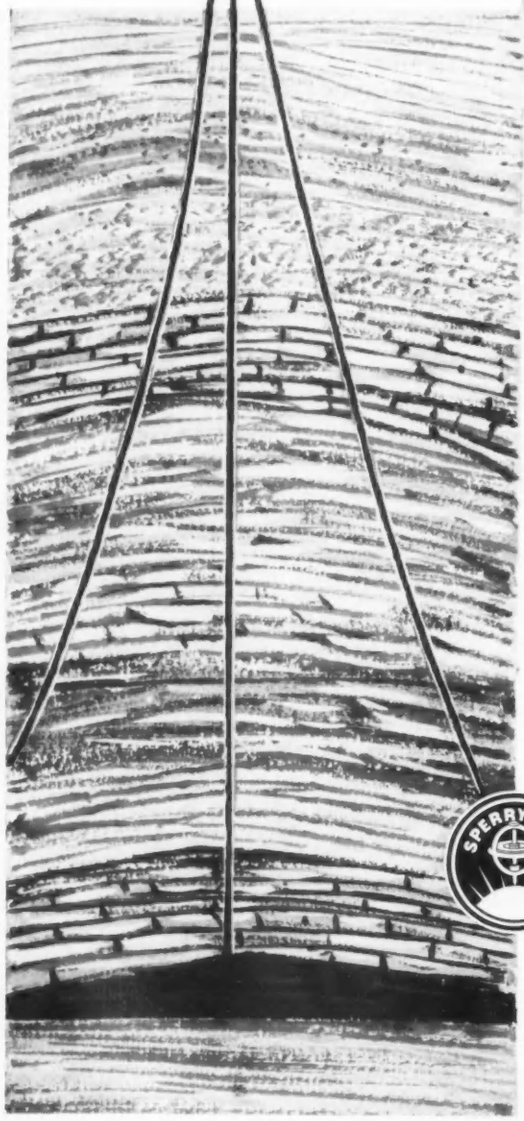

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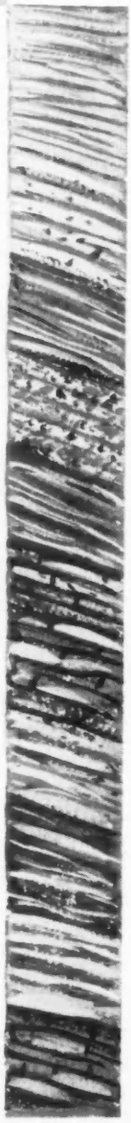

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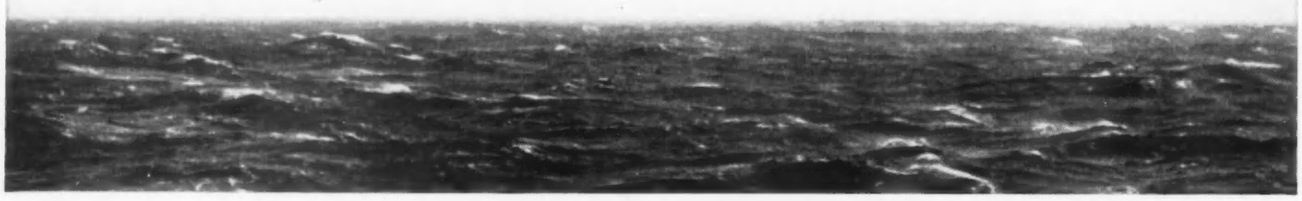

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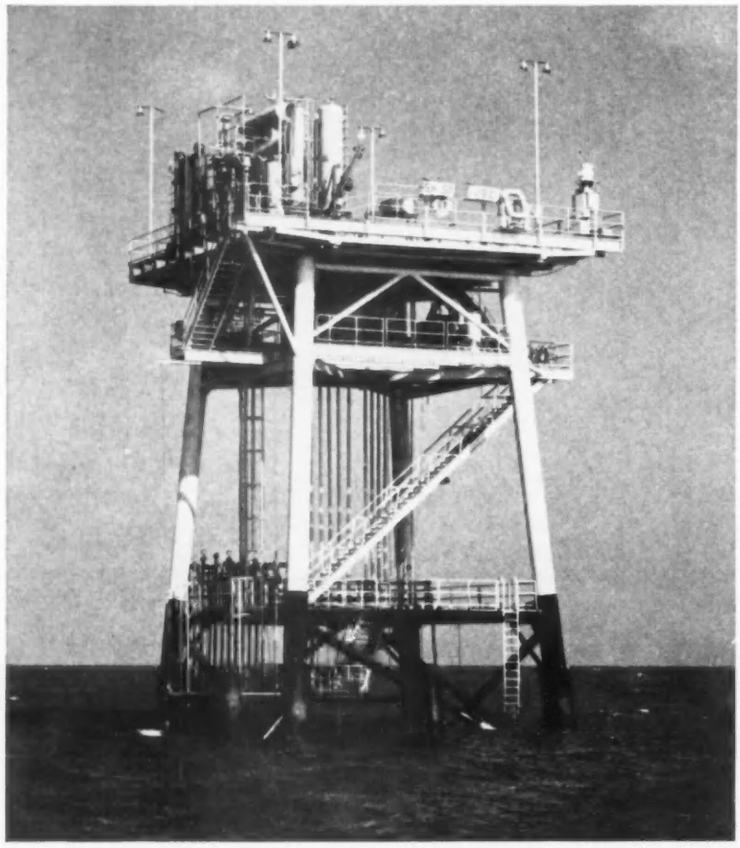

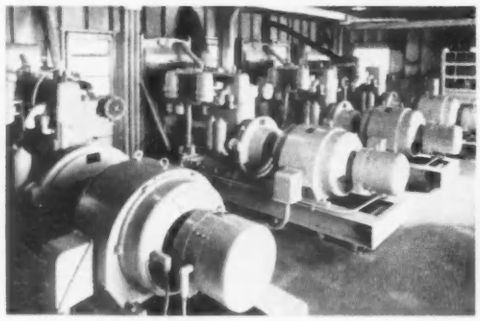

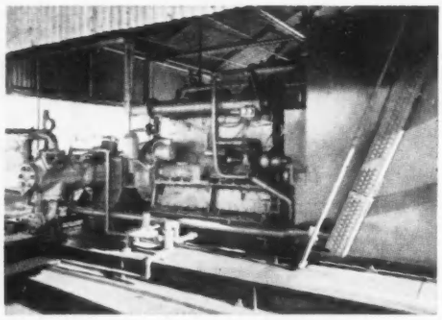

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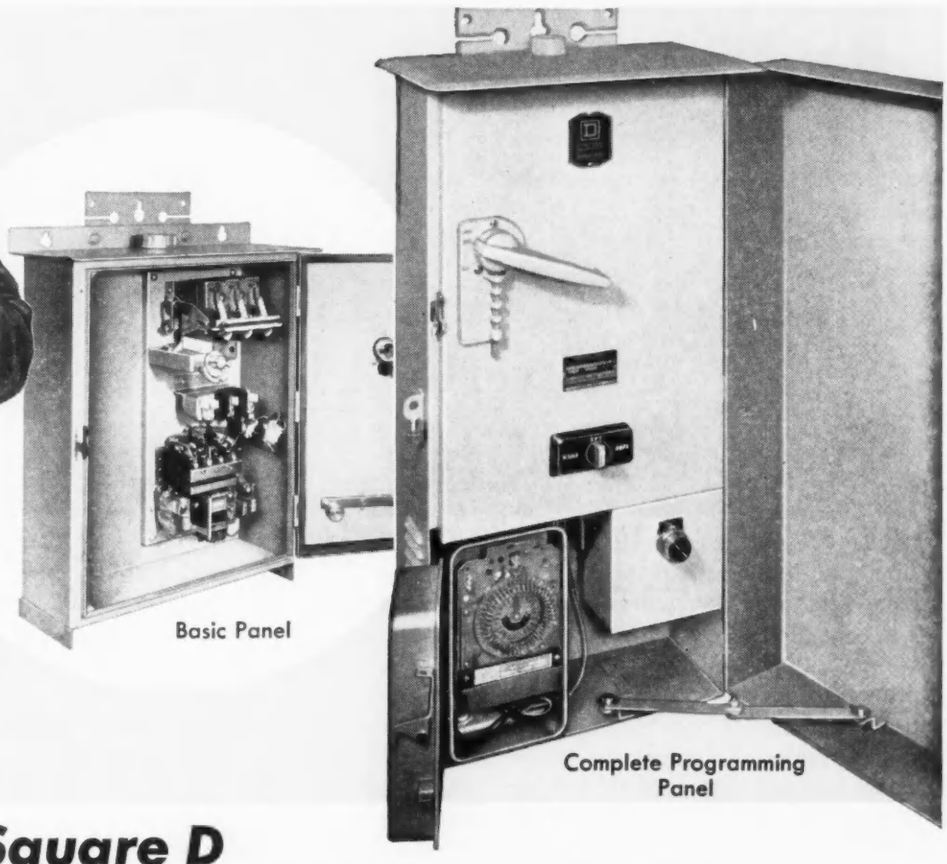

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South Texas

Here, the operator added 6 lbs of SOLTEX per bbl to a 17.4 lbs/gal inhibited mud before drilling into a section noted for such troubles as sloughing shale, pipe drag, high torque, and differential pressure sticking. Casing was set at 11,466 feet near the top of the trouble zone.

After adding SOLTEX, the well was completed to 12,250 feet in record time. From past experience in the area, the operator feels that this could not have been done without the SOLTEX treatment that improved mud properties and completely eliminated the usual hole troubles.

Offshore Louisiana

In this case, the operator was in trouble at 10,200 feet because of sloughing, sticky shale, hole bridging and pipe drag. Six lbs of SOLTEX per bbl and 1½ lbs of Technical Grade Driscose* per bbl were added to a 12.8 lbs/gal inhibited mud. Sloughing was eliminated, pipe drag was reduced from 50,000 lbs to 10-15,000 lbs, and no bridges were encountered when drilling to TD at 11,850 feet. The well was logged, casing run and cemented without difficulty.

California

This well had been sidetracked at 10,000 feet and the hole was deviated 23°. Hole conditions had become progressively worse, making it necessary to drill in and out of the hole. Approximately 2½ lbs of SOLTEX per bbl were added to the sodium base mud. Hole conditions improved and drilling continued with no further trouble encountered.

Oklahoma

At 13,784 feet, 2 lbs of SOLTEX per bbl were added to a 12.8 lbs/gal mud to help stabilize hole conditions. Torque was reduced 50% after the first circulation. Flow properties of the mud improved, pump pressure decreased, and penetration rate improved.

South Louisiana

The operator on this well credits SOLTEX for saving the hole. Sloughing shale was encountered below 11,000 feet. Unable to run logs, the section was reamed twice before tools could be run to bottom. After logging, the hole caved in. Five lbs of SOLTEX per bbl were added over one circulation. The service engineer reported that within three hours the hole was clear. Drilling was resumed and continued to total depth with no further trouble encountered.

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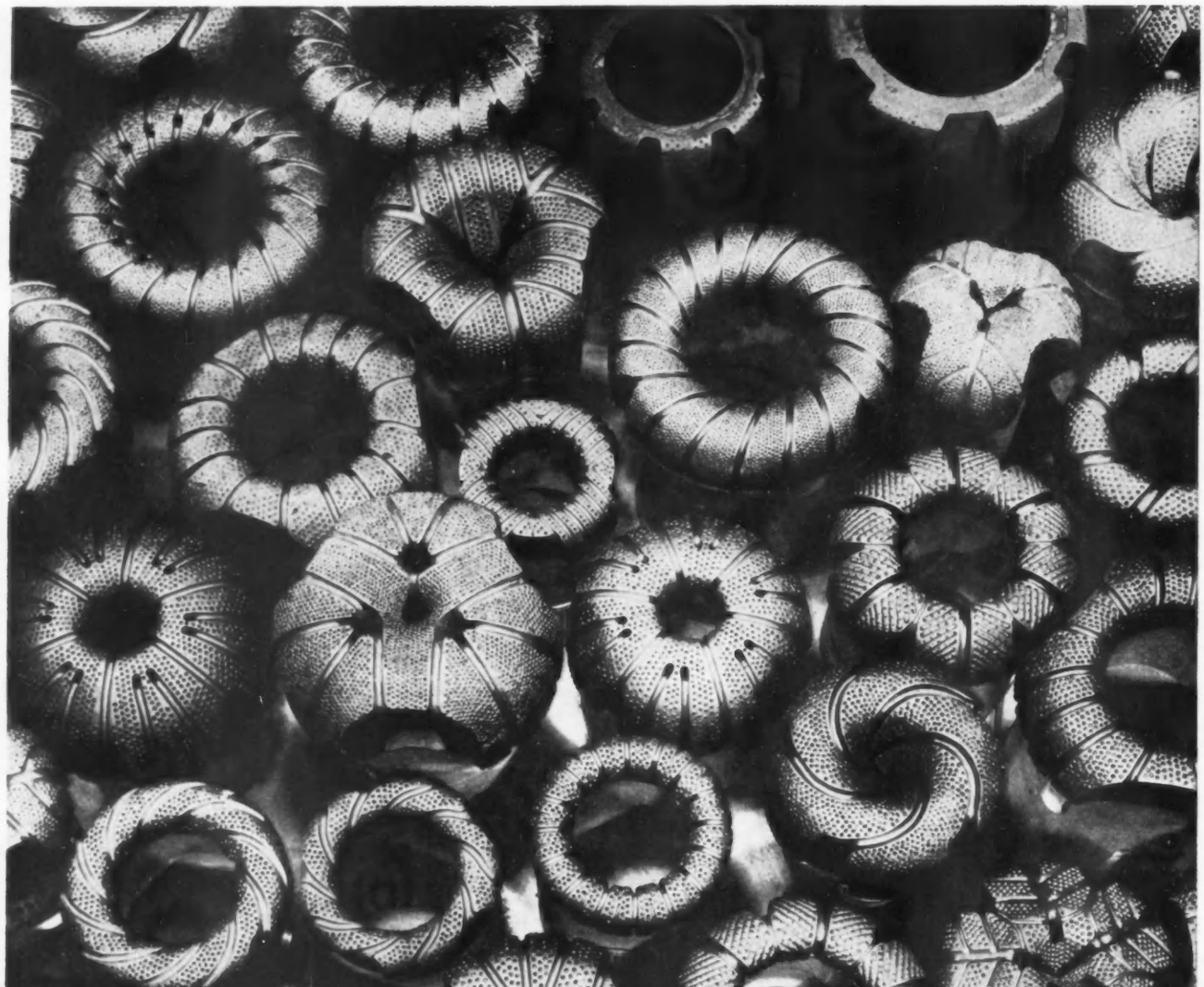

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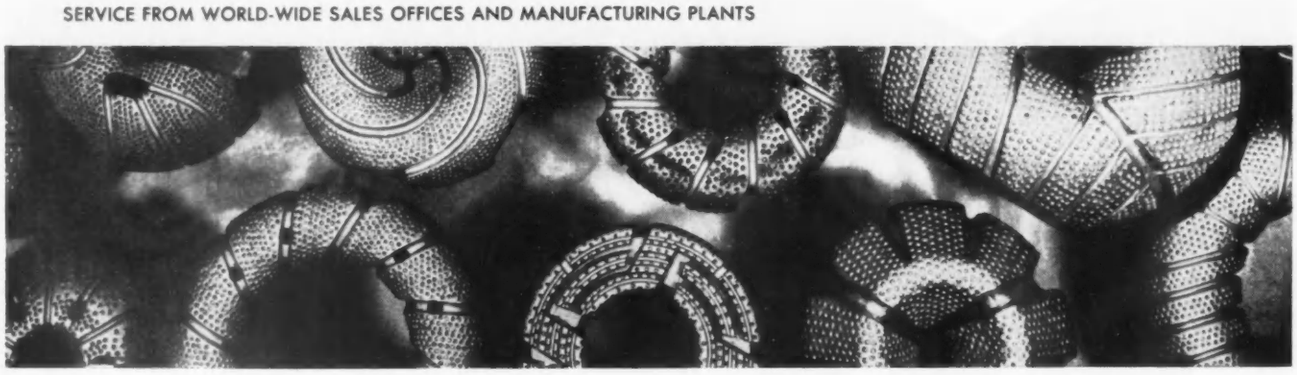


MILLIONS OF YEARS IN A MATTER OF HOURS

Anhydrite (white) replacing dolomite.

That's the effect Dr. Robert Sippel achieves when he foreshortens geologic time with the two-million-volt Van de Graaff accelerator shown with him in the picture at the right.

What's his hurry?

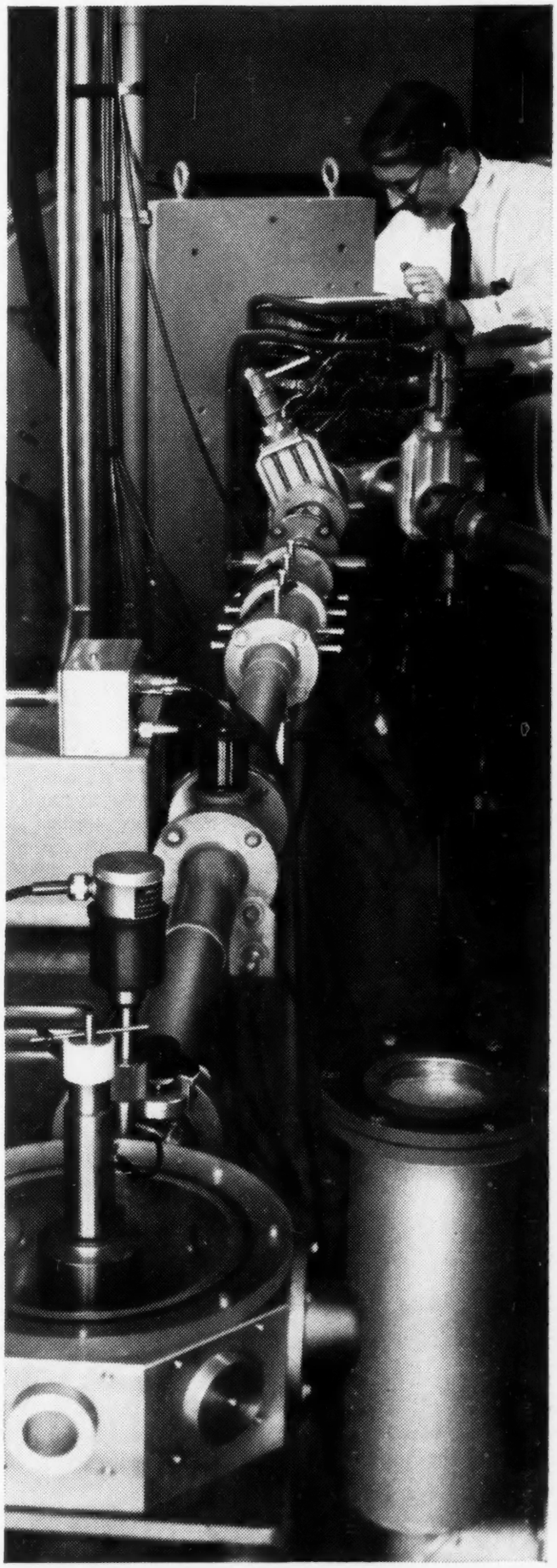
This: The Socony Mobil scientist wants to find just how, and how fast, one solid rock can be penetrated and displaced by another. Geologists call this "replacement." The small picture above gives a striking illustration of the invasion of one rock by another.

Dr. Sippel's interest is understandable. The way one kind of rock replaces another is closely linked with the formation of oil reservoirs. Better understanding of it will help in the endless search for new oil reserves. This is part of Bob Sippel's job as a scientist in Socony Mobil, the first company to apply the Van de Graaff instrument to petroleum exploration and basic geological research.

Dr. Sippel uses the high-energy accelerator to bombard solids with protons traveling at almost the speed of light. This bombardment makes possible extremely sensitive analysis. With this, Dr. Sippel can measure processes so slow in nature that even if you could watch for a million years, you wouldn't be able to detect any change. His studies are so sensitive that he can detect and identify a layer of atoms ten billionths of an inch thick.

Dr. Sippel is one of the 1,500 men and women engaged in Mobil's $25,000,000-a-year research program – in which imagination is turned into ideas, and ideas into better products and processes.

Probing the far frontiers of science pays off not only for Mobil, but for everyone who does business with Mobil – customers, employees, licensees, and investors.



Dr. Robert F. Sippel's interest in nuclear geology has a two-fold ▶ origin. At Rice University, where he received his doctorate, he concentrated on nuclear physics. His interest in geology developed after joining Socony Mobil, in 1954. Mobil scientists are encouraged to explore research areas stemming from their own special talents and interests.

Mobil

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For more data on advertised products, use cards, last page.

the case for using a SWACO D-GASSER on most of the wells you drill

Many operators and drilling contractors don't realize how D-Gassers can help them reduce the over-all cost of wells. By removing entrained gas and air from drilling mud after each circulation, the D-Gasser permits improved control of mud characteristics. As a result, many operators can profit from some of the following savings:

SAVES MUD AND CHEMICALS. If gas-cutting is encountered, the chances are good you can save on mud bills. The D-Gasser usually permits drilling without adding weighting material even though the well is "kicking" from drilled gas. It has been possible to keep mud weights more than a pound lighter than would have been possible without the D-Gasser. Over-treatment of mud (and the resulting stuck pipe and formation trouble) can be avoided when the D-Gasser is used. Trip gas and viscosity increases due to dissolved and entrained gas may be controlled without costly and time-consuming mud treatment.

SAVES LOST CIRCULATION MATERIALS. Since the D-Gasser often makes it possible to continue drilling while the well is "kicking", lighter mud can be used and lost circulation problems may be held to a minimum.

PERMITS FASTER, LOWER COST DRILLING. Drilling rates and/or footage per bit may be increased since light, low-solid muds may be used. Total drilling time may be reduced and fewer round trips may be required.

SAVES CASING. Frequently, operators avoid the expense of setting a long string just to evaluate a minor gas show. By eliminating the recirculation of gas, the D-Gasser prevents exaggerated impressions from minor shows. Occasionally, it has been possible to save an intermediate string when a D-Gasser is used.

SAVES WELLS. Many high pressure exploratory wells have actually been saved by the D-Gasser. Costly blowouts, fires and lost holes have been avoided. For full information on how the D-Gasser can help you, contact your nearest SWACO representative or write us direct.

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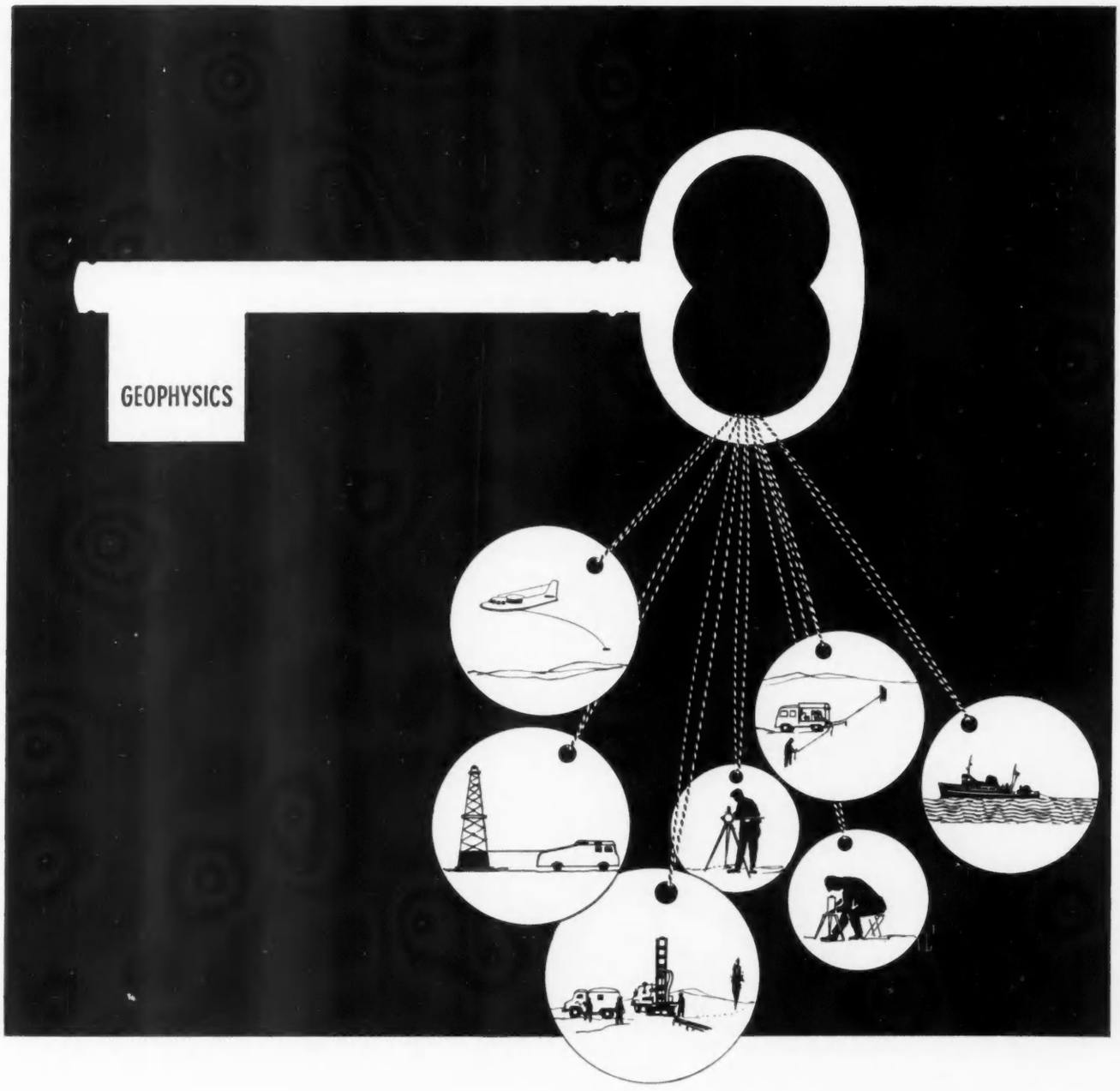

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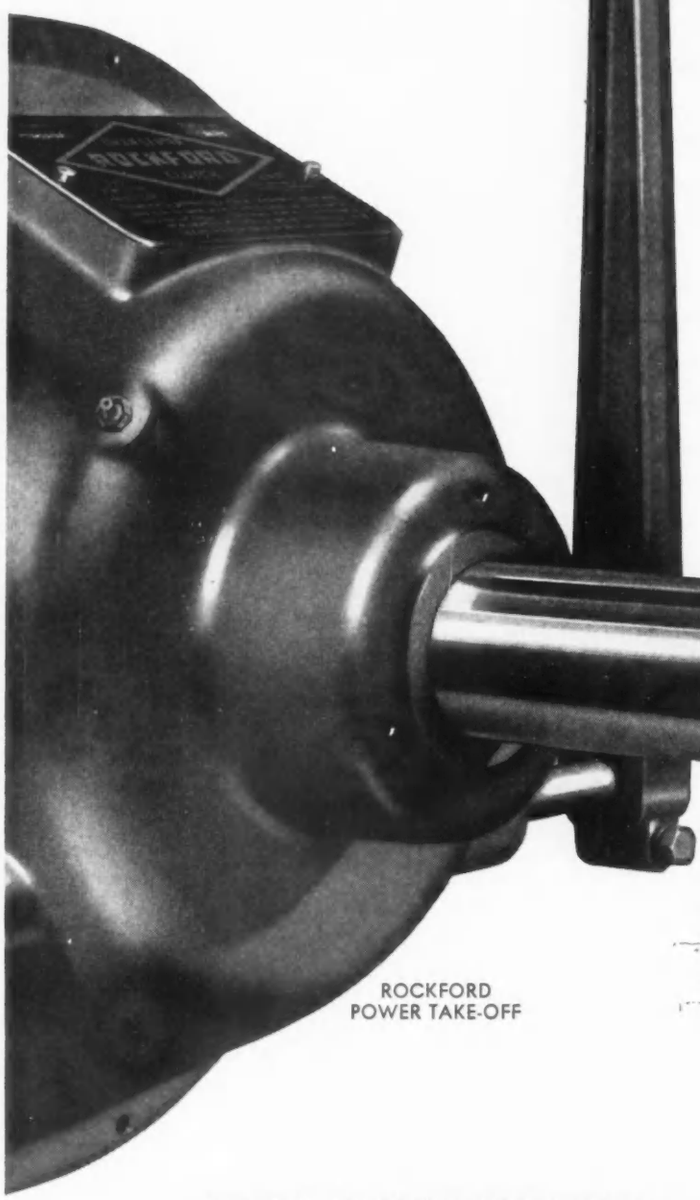

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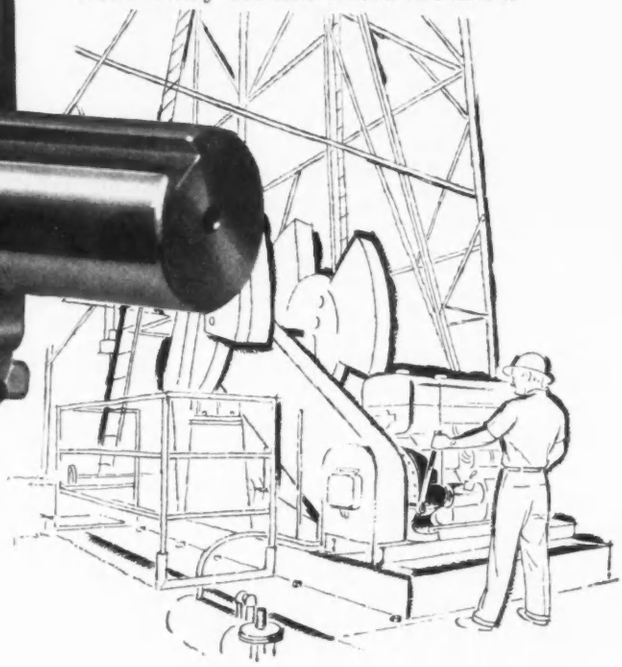

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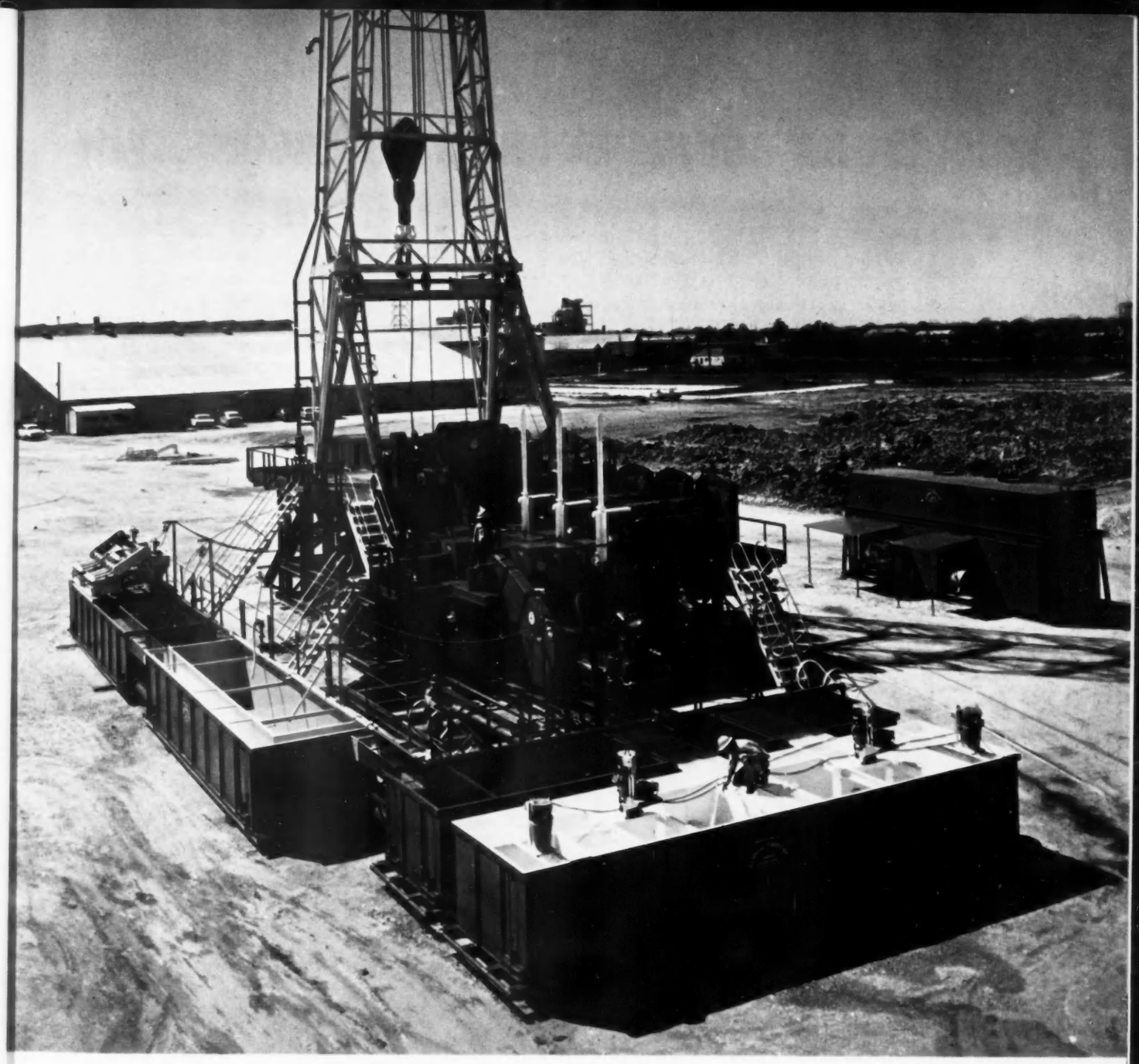


SPENDING DAYS TO SAVE WEEKS

When a National Supply drilling rig customer orders a "rig-up," he spends a few days — that can be spared — to save weeks that would be far more expensive to lose.

In a "rig-up," all components of a drilling rig — engines, pumps, drawworks, rotaries, etc. — are completely assembled at the Houston plant before shipment. The rig is then test-operated to make sure everything is in order.

Parts can be color-coded, so their place in the final assembly is immediately apparent. Erection, even at some far-away spot, is thus simplified and speeded. Difficulties and delays are virtually eliminated.

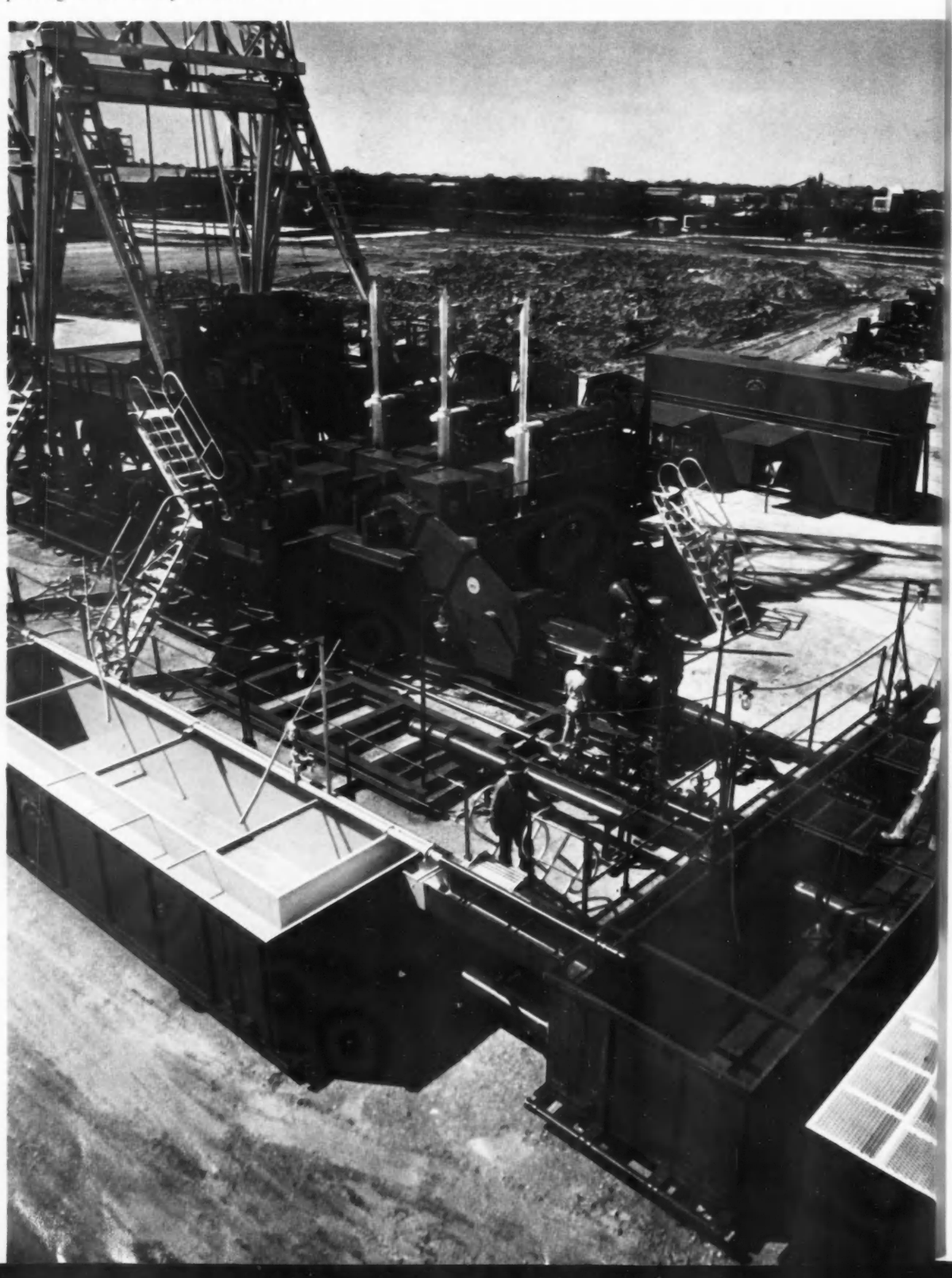
Customers using these National test-assembled rigs report *faster rig-up time than previous field assemblies.* For either domestic or overseas operations, it can be the best insurance you ever bought. Ask your representative for details, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

On next pages:
National Supply rigs

FOUR SOUND, ECONOMIC REASONS WHY

A RIG FOR EVERY NEED. National's complete line of thirteen rigs serves every hoisting and drilling requirement — from shallow wells, to the world's deepest wells, including well servicing and workover. If mobility is a problem, we can furnish truck or trailer mounted rigs, helicopter rigs, rigs packaged into easily airborne units.

EXTRA ENGINEERING. There are no compromises in the design or materials of National rigs. In fact, each one has extra built-in stamina that many National rig users call the "driller's margin." This margin accounts for important performance differences on every well.



NATIONAL RIGS ARE INVARIABLY FIRST CHOICE

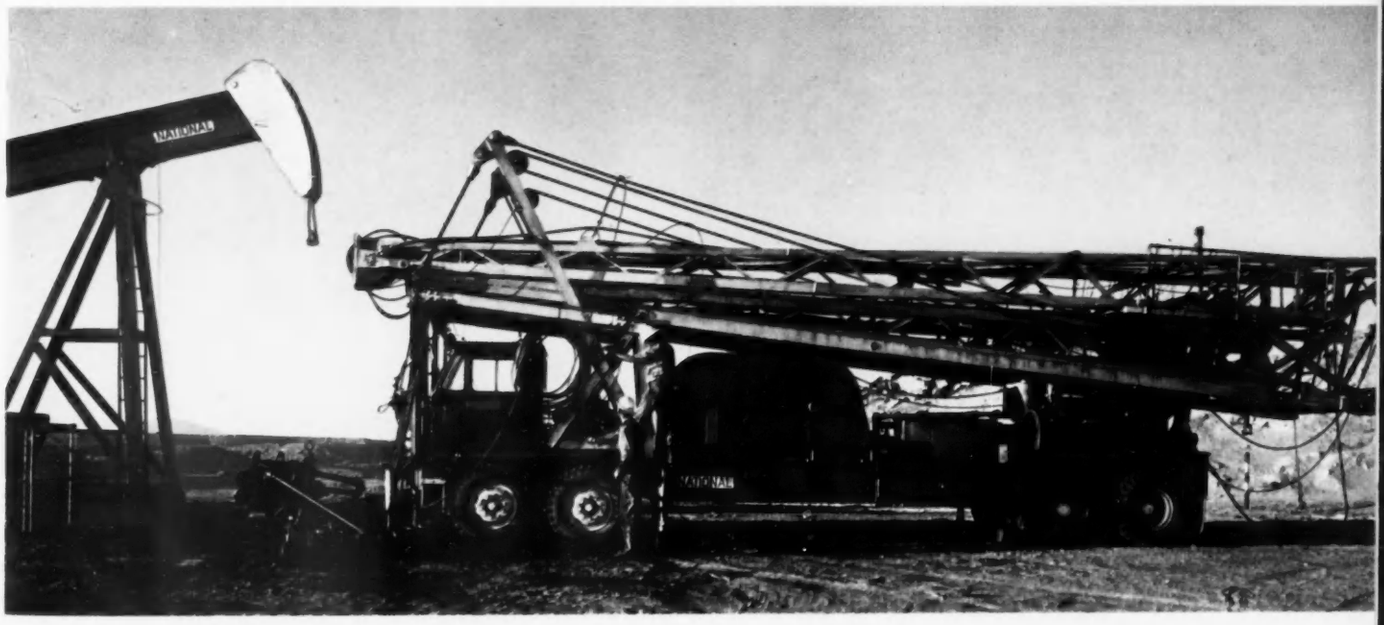
OPTIONAL RIG-UP SERVICE. Before a rig is shipped, it is completely assembled and test-operated, lubricated and adjusted. Related units can be color-coded for fast, simple assembly. If additional companion equipment or services are required, they are furnished immediately.

WORLD-WIDE SUPPLY SERVICE NETWORK. National Supply rigs are now operating around the world. And National Supply has the facilities and representatives around the world to furnish complete, economical technical assistance when needed. This service is one reason why National Supply is the world's largest supplier of oil country equipment.

A National Supply representative will be happy to point out the advantages of each of these rigs, or you can get details by writing to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

NATIONAL DRILLING RIGS

TYPE	INPUT HORSEPOWER RATING	DEPTH RATING (NOMINAL FT.)
T-12	200	1,500 to 3,000
T-20	300	2,000 to 4,000
T-32	400	3,000 to 5,500
T-45	550	4,500 to 7,500
55	700	6,000 to 9,000
80-B	1,000	8,000 to 12,000
110	1,375	11,000 to 16,000
130	1,625	13,000 to 20,000
Helicopter		
4-10	600 to 1,000	5,000 to 10,000
Drive-in Units		
200	150 to 250	
300	250 to 350	
Diesel-Electric Drawworks		
1320-DE	1,625	13,000 to 20,000
1625-DE	2,500	16,000 to 25,000



This National Model 300 Drive-in rig is pulling into a remote location in Colorado for workover service. Both National Supply self-propelled Drive-in rigs, the Model 200 and the Model 300, are carefully engineered for every oil country job from rod and tubing servicing to deep workover.

This Type 55 rig is ready for shipment to Iran after test rig-up at National's Houston plant. This rig has a National drive group with three Superior engines and National torque converters, and a National K-700 slush pump with a National dampener.

Steel

Steel's Symbol of strength, long life, and economy

NEW NATIONAL MICROMATIC DRILLING CONTROL CAN LOWER DRILLING COSTS

National's new Model #6 Drilling Control is a rugged, dependable device that automatically operates the drawworks just as the most experienced driller does, and insures the exact penetration rate desired. Usable on almost every new and old drawworks, the Micromatic feeds off the drilling string smoothly and continuously, with maximum safety. Unit is compact, easy to install. Installation time is about six hours and can be done on location.

With the National Micromatic, the drilling string is under complete control at all times; weight on the bit can be increased or decreased at will; and the control can be engaged or disengaged in minutes.

The driller first obtains the desired amount of weight on the bit; snaps and locks the control connecting rod to the brake lever and then opens two air valves in the control cabinet. The Micromatic takes over and maintains the desired weight on the bit.

Ask a National Supply representative to point out how the Micromatic can speed your drilling operations. Or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

Micromatic controls are within easy reach of the driller and can be engaged or disengaged in a matter of moments. Controls are circled in red on illustration at right.

ARMCO National Supply Division

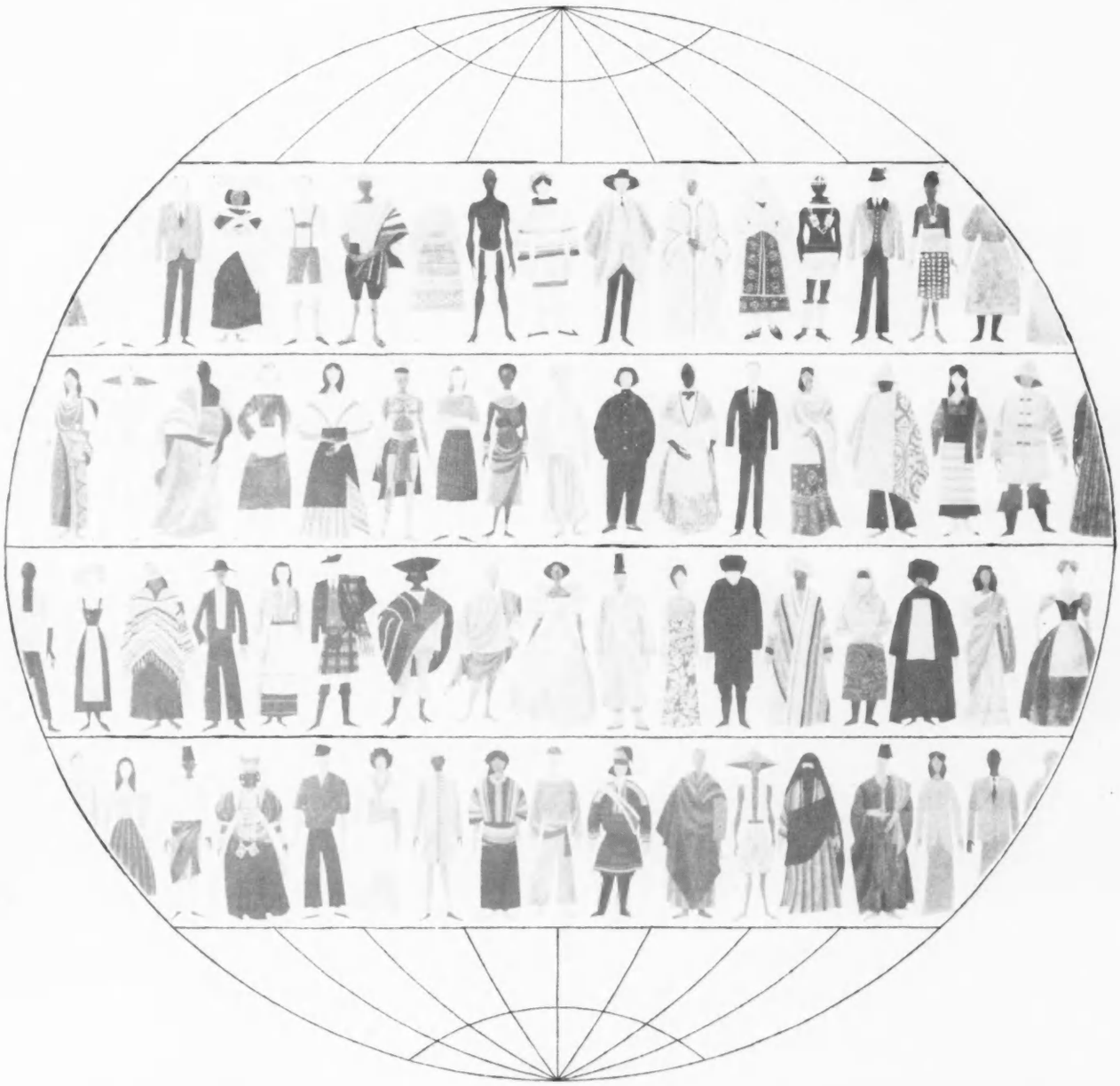
3 billion . . .

Twice as many people on earth today as 50 years ago. Within the next half century, population expected to double again! How will the earth feed, clothe, house, these teeming millions?

Through energy! Fuel energy! To grow the food, produce the goods the world must have to meet the needs of its increasing population and lift its living standards. Man cannot add an acre to the earth. But energy will add life to every acre he does use.

TIME BOMB

We explore for, produce oil and natural gas from northern Canada to the southernmost tip of South America. We refine and process oil and natural gas and market their products in 24 states. Each year we supply more and more of the energy on which the future depends.



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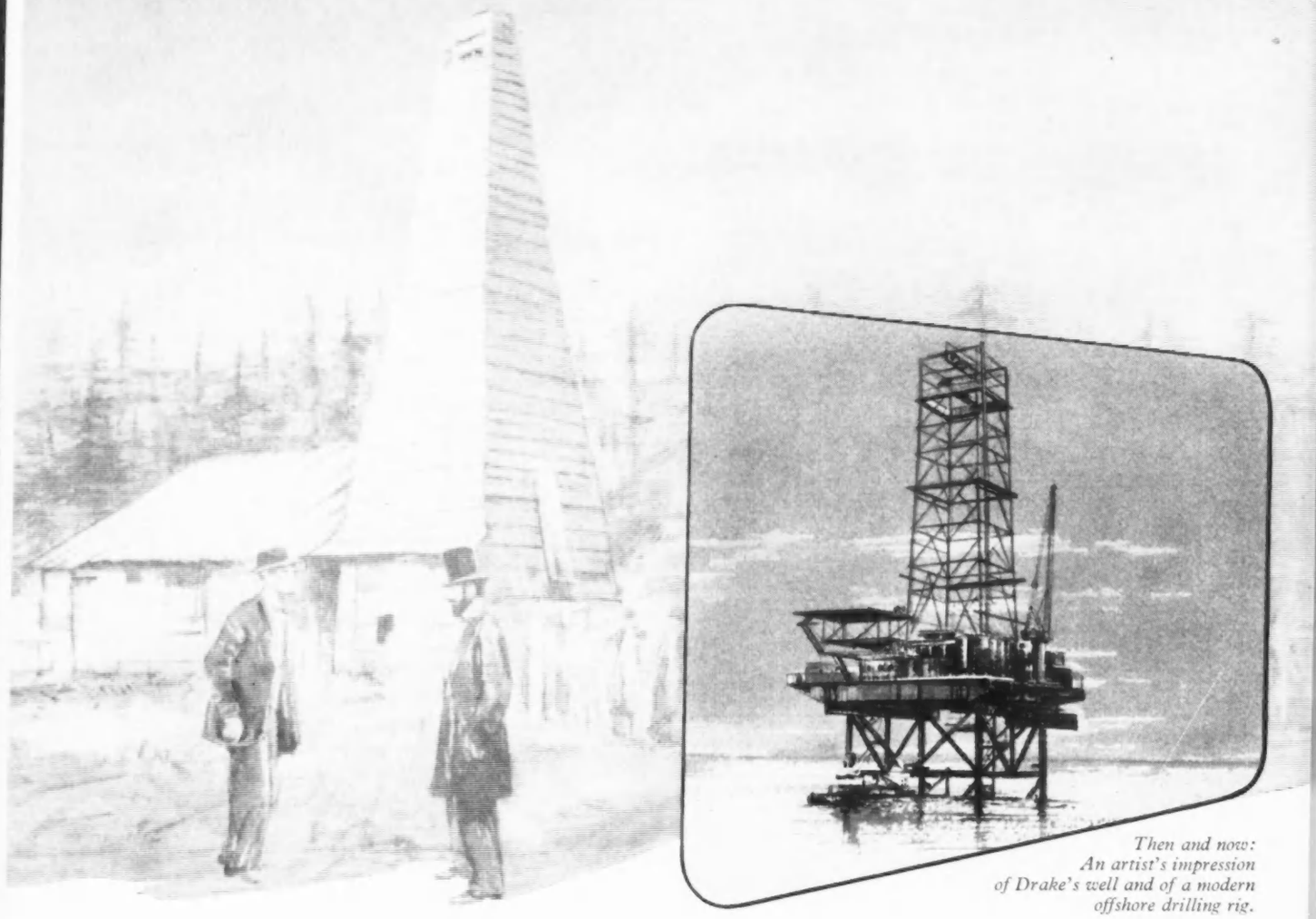

Then and now:
An artist's impression
of Drake's well and of a modern
offshore drilling rig.

A HUNDRED YEARS OF TUBE MAKING

In 1859, at the time Drake's well was being drilled, the founders of Stewarts and Lloyds were already making steel tubes. Now, with a hundred years of experience behind them, S & L are one of the largest manufacturers of steel tubes in the world.

The Company's products are used in oilfields and refineries throughout the world. These products include oil well casing, tubing and drill pipe, line pipe, fabricated pipework, butt-welding fittings and various types of carbon and alloy steel tubes required for oil refinery and chemical plant.

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LICENCE NO. 1

Stewarts and Lloyds were the first manufacturers in the world to be licensed by the American Petroleum Institute to apply the A.P.I. monogram to their oil country tubular goods.

Enquiries should be addressed to

S&L

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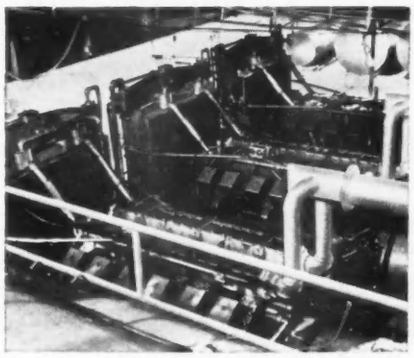
it's CLIMAX

for DRILLING and PUMPING



● Climax Engines have proven their reliability in hundreds of oil field installations. Single, well balanced design, rugged construction, and quality materials make them smooth running . . . for years!

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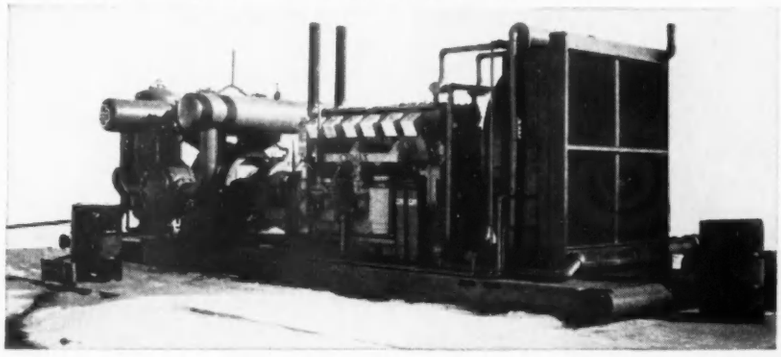
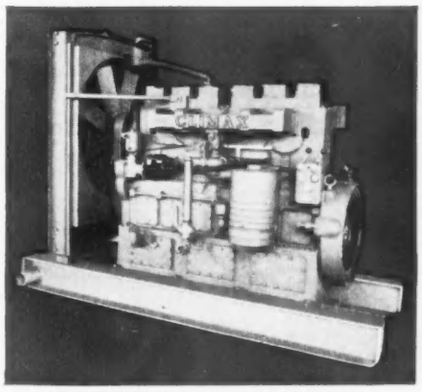
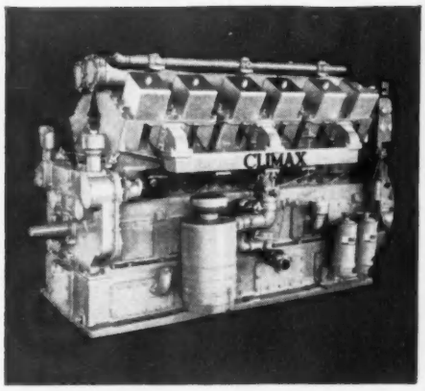
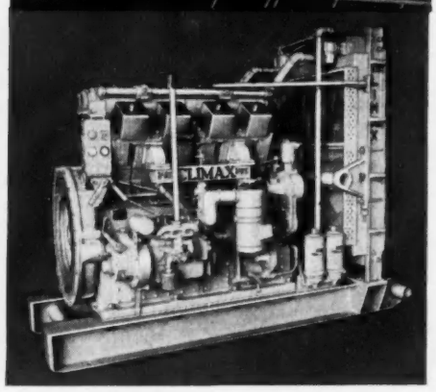




Model K-67—Max. hp 265 (Natural Gas)



Model V-125—Max. hp 605 (Natural Gas)



Model V-85—Max. hp 390 (Natural Gas)

CL-116-R

CONT. DUTY (NAT. GAS) →			DRILLING-PUMPING (80% RATINGS)						COMPRESSORS (65% RATINGS)				
Model	Bore & Stroke	Displ.	Peak Torque @ RPM	Brake hp at Speeds Indicated					Peak Torque @ RPM	Brake hp at Speeds Indicated			
				600	800	900	1000	1100		800	900	1000	1050
R-165	6⅛ x 7	1238	684 @ 750	81	105	117	127	135	557 @ 800	85	95	103	108
K-67	7 x 7	1616	955 @ 850	110	145	161	176	188	775 @ 800	118	131	143	149
K-75	7½ x 7	1855	1090 @ 800	126	166	185	204	218	885 @ 800	135	151	166	174
V-80	7 x 7	2155	1240 @ 850	140	188	210	230	246	1002 @ 800	153	171	187	194
V-85	7½ x 7	2474	1460 @ 800	164	223	246	266	284	1185 @ 800	181	200	216	222
V-122	7 x 7	3232	1920 @ 800	217	293	328	353	378	1562 @ 800	238	265	288	300
V-125	7½ x 7	3711	2240 @ 850	242	340	384	417	442	1820 @ 900	276	312	340	354

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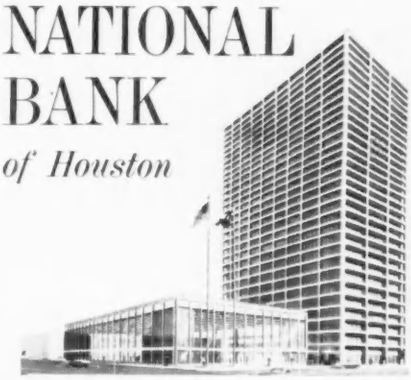

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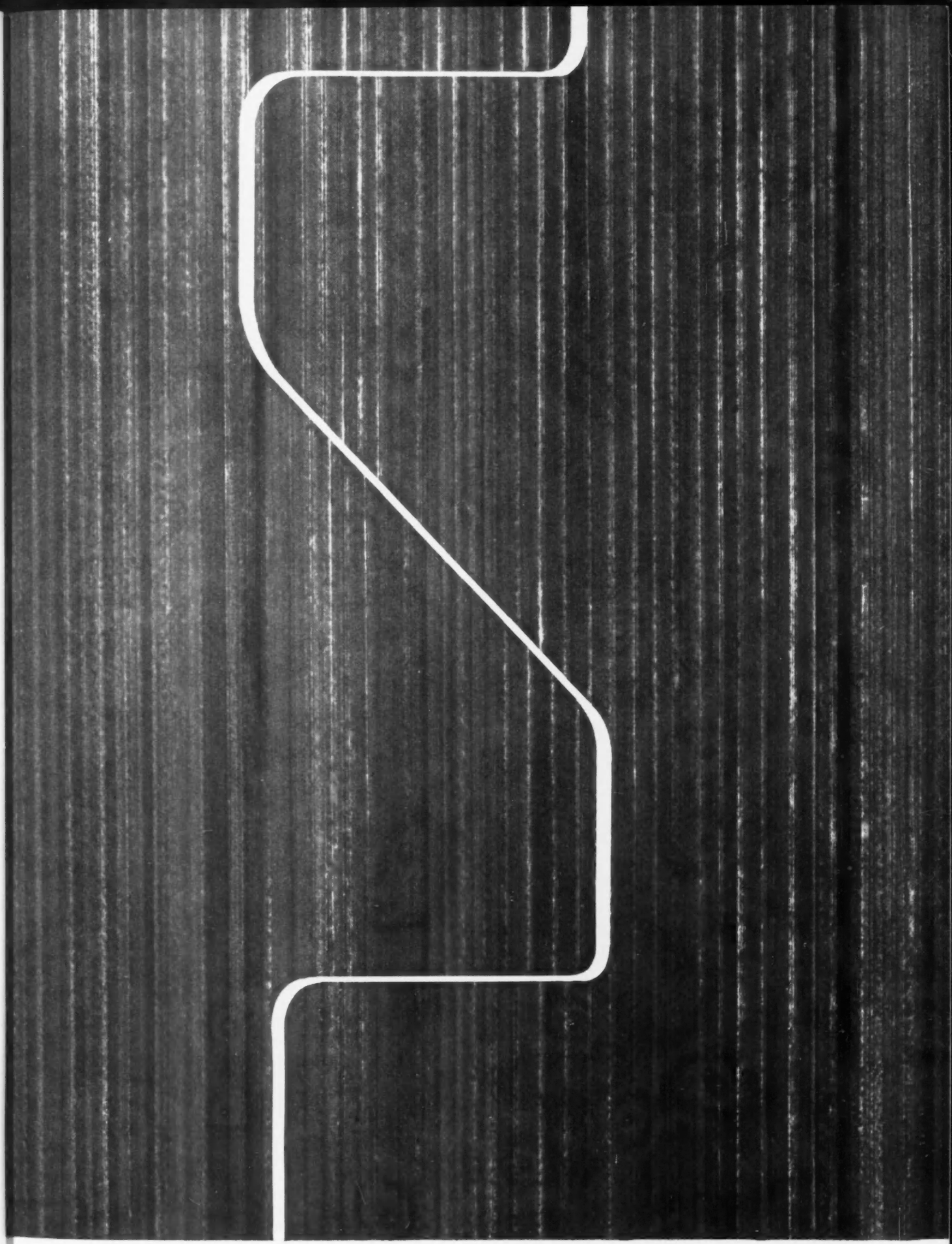
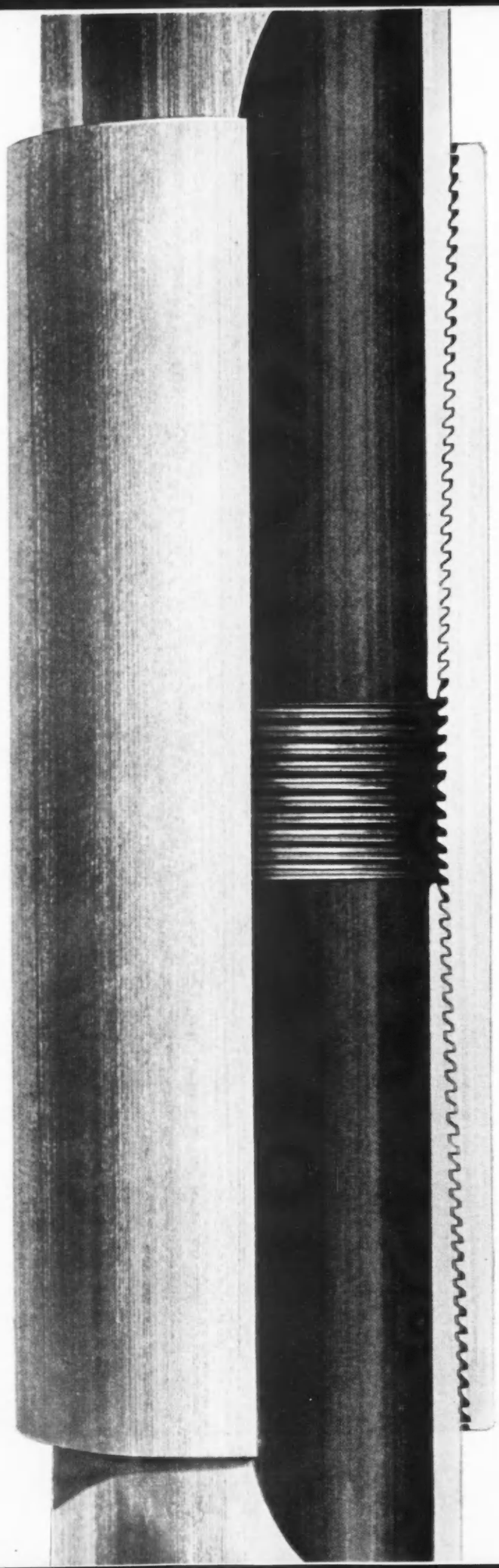


This advanced thread design cuts pipe costs...



Until recently, oil country casing and tubing had utilized upset ends to strengthen the joint for deeper wells. But this joint thickening meant a loss of valuable space within the casing—space that's more important than ever with the trend toward more multiple completion wells and slim hole wells.

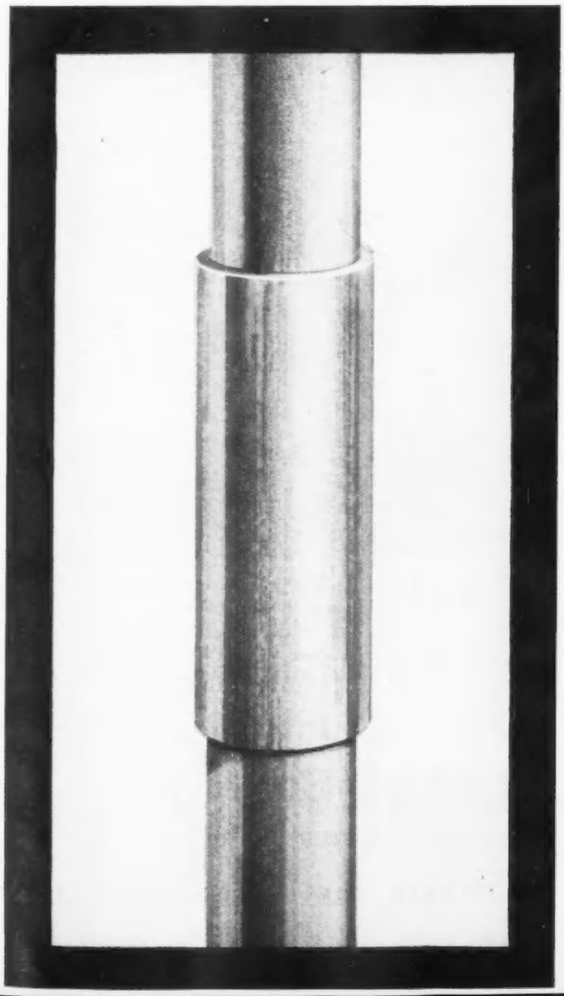
National Tube has developed a non-upset joint—the cost-saving USS National Buttress-Thread joint. The unique run-out design and flank angle of the Buttress-Thread gives pipe all the strength it needs. In fact, the joint strength is comparable to that of the body of the pipe. The Buttress-Thread eliminates the need for the internal upset in casing, as well as the external upset in tubing. Now there's maximum hole clearance, and multiple tubing strings can be run with minimum interference.

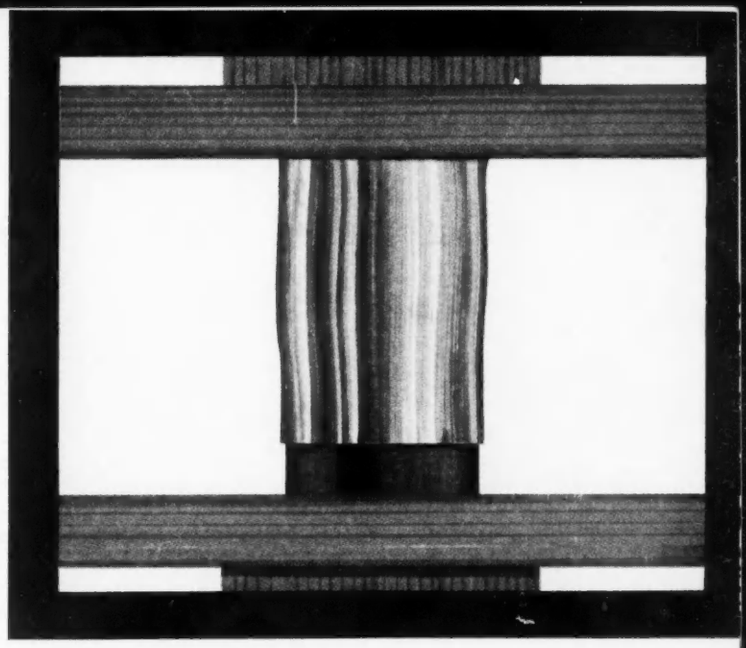
To prove the exceptional strength of the Buttress-Thread casing joint, National Tube engineers drove pipe nipples into the coupling until the threads tore loose. Despite this brutal pounding, the coupling did not

fail—the joint remained intact.

The latest adaptation of the Buttress-Thread is to oil well tubing. USS National Buttress-Thread tubing can be readily stabbed firmly into a coupling without thread damage or cross threading. Mill tests show joints can be made up and broken at least 12 times without thread damage or impairment to joint performance. Make-up time is faster because the pipe slips easily into the coupling, and engages immediately. Then 2½ turns make the joint gas-tight.

The coupling threads are





heavily tin-plated so gas won't leak even at pressures of 15,000 psi. You get more use out of Buttress-Thread tubing because, unlike upset pipe, if ends are damaged, they can be repaired by cutting new threads right in the field. For more information on casing or tubing with the Buttress-Thread, call or write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Penna.

USS and National are registered trademarks

USS

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

This mark tells you a product is made of modern, dependable Steel.

Three A-C Thousand Series diesels are "doing good job with greatest of ease—

Have Cut Fuel Bills to 30%"

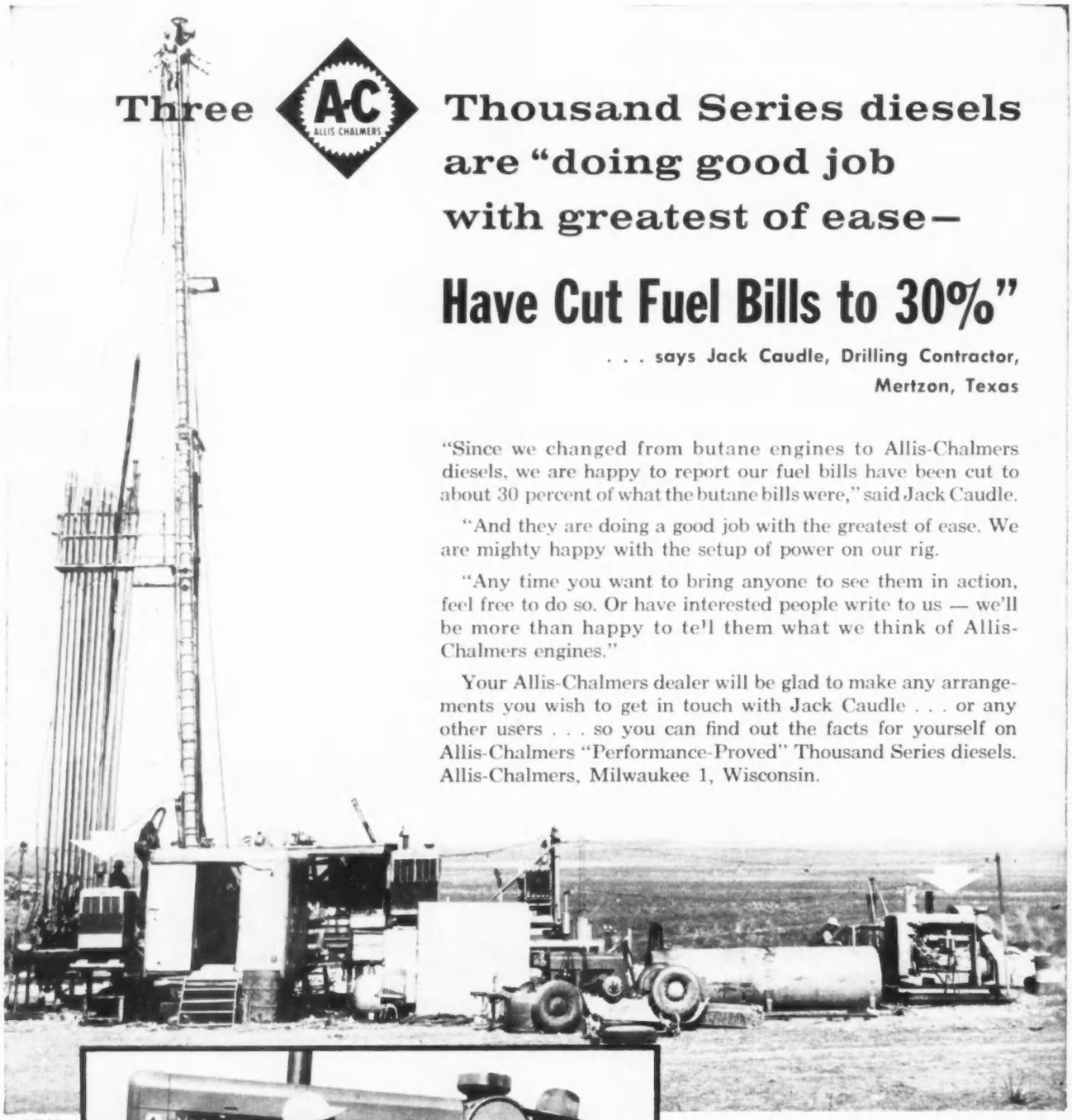
. . . says Jack Caudle, Drilling Contractor, Mertzon, Texas

"Since we changed from butane engines to Allis-Chalmers diesels, we are happy to report our fuel bills have been cut to about 30 percent of what the butane bills were," said Jack Caudle.

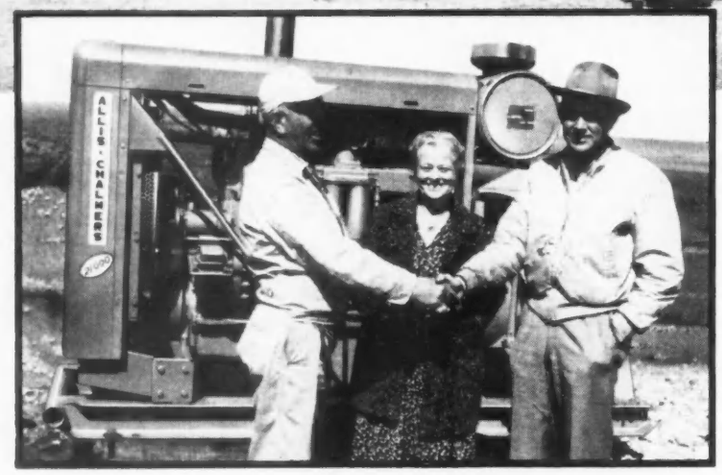
"And they are doing a good job with the greatest of ease. We are mighty happy with the setup of power on our rig.

"Any time you want to bring anyone to see them in action, feel free to do so. Or have interested people write to us — we'll be more than happy to te'l them what we think of Allis-Chalmers engines."

Your Allis-Chalmers dealer will be glad to make any arrangements you wish to get in touch with Jack Caudle . . . or any other users . . . so you can find out the facts for yourself on Allis-Chalmers "Performance-Proved" Thousand Series diesels. Allis-Chalmers, Milwaukee 1, Wisconsin.



BO-11



▲ A real money-making trio for the Jack Caudle Drilling Company! Left: Allis-Chalmers 10000 on the rotary table. Center: The 16000 on the draw works. Right: The 21000 on the mud pump.

◀ While Mrs. Caudle looks on approvingly, Jack Caudle (left) and Bryant Williams, of the M. D. Bryant Ranch, near Mertzon, Texas, congratulate each other on bringing in a producing oil well March 1, 1961. The drilling is being done on the Bryant Ranch.

ALLIS-CHALMERS

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Varying according to the specific requirements we supply the following products made of standard and special steels as well as of clad plates:
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coke towers · vacuum towers
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evaporators · heat exchangers · coolers
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as strip-wound pressure vessels
or solid vessels
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storage vessels for liquids and gases
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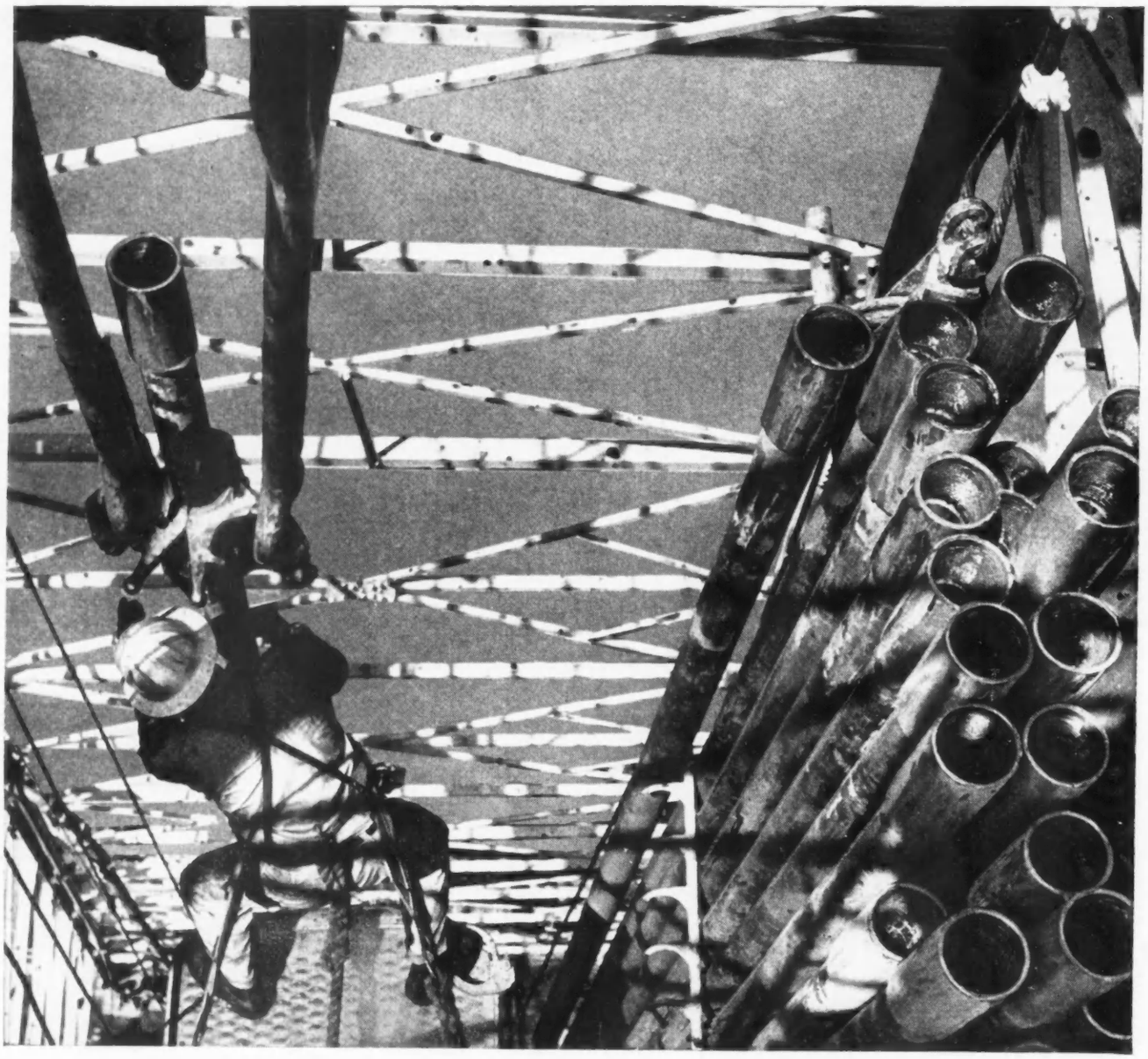

To keep drilling costs down as wells go deeper, use 4340 nickel alloy steel drill pipe

Keeping cost-per-foot down is a tough challenge when you're drilling to 15,000 feet—or deeper—to bring in a well.

When high drilling costs threaten to make today's extremely deep wells uneconomical, drillers need extra ingenuity *plus* stronger, tougher equipment.

Drill pipe made of 4340 nickel alloy steel is an important cost-cutter With this steel you get a reserve of strength for dependable penetration of extra thousands of feet: basic resistance to fatigue, impact, and abrasion.

Here's why more and more operators are using 4340 drill pipe for deep-hole drilling. This 1.85% nickel steel, readily heat-treated to high yield strengths, stands up to the *severest* torsional and impact stresses. Strong *and* ductile, it takes shock-loading in stride.

When you order drill pipe for your next deep well, remember that 4340 nickel alloy steel has *proved* dependable in the toughest drilling service . *wells as deep as 25,000 feet*. It's your best insurance against drill-pipe failure.

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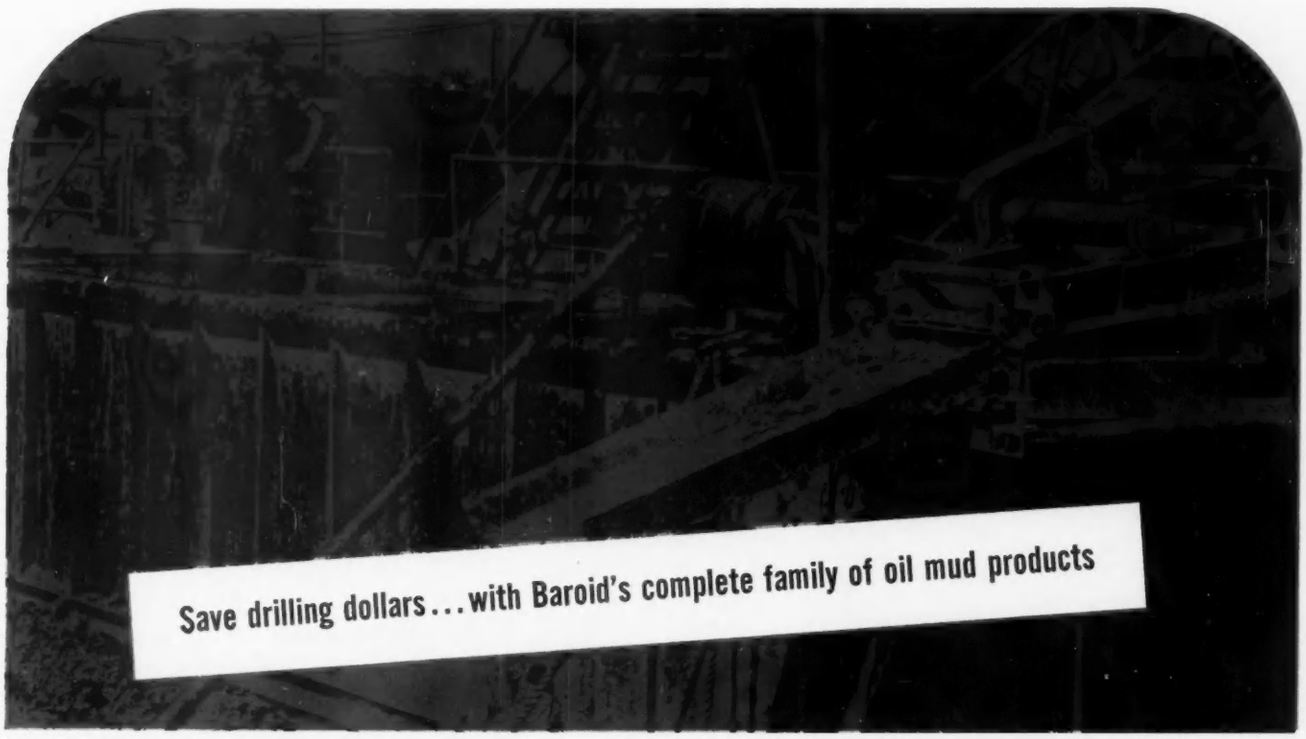

Baroid Field Report: Terrebonne Parish, Louisiana. This case history exemplifies the use of one type of Baroid Oil Mud to solve this particular problem.

Baroid Oil Mud solves deep drilling problem (BHT 300 F)

In a recently completed well in the Hollywood Field, Terrebonne Parish, Louisiana, a Baroid Oil Mud containing INVERMUL*, DURATONE** and PETROTONE* was used as the practical solution to the problem of drilling a 5¾ inch hole at depths to 16,500 feet and temperatures to 300 F.

Tight-hole conditions had been experienced while drilling to 15,000 feet and a 7 inch OD liner to be set (in 8¾ inch hole) at this depth was stuck at 14,327 feet. A Baroid Oil Mud was selected to drill the bottom 1,470 feet of hole because of the excellent control of flow properties, hole stability and lubrication that would be attained. API filtration could be held at zero, filtration at anticipated bottom-hole temperature of 275 F to 300 F could be easily controlled, and flow properties comparable to water-base muds could be achieved.

At 14,327 feet the water mud in the hole was displaced with approximately 1,500 barrels of pre-mixed 17.5 ppg Baroid Oil Mud. The 7 inch liner was cemented, cement was drilled, and reaming to bottom was begun. While reaming to bottom, the water mud (about 5% of total mud volume) was incorporated into the Baroid Oil Mud with no difficulty.

The 5¾ inch hole was drilled from 15,100 to 16,570 feet at about the same penetration rates normally attained with water muds. Periodic additions of diesel oil, INVERMUL emulsifier and DURATONE filtration control agent maintained the excellent filtration and flow properties of the oil mud. Drilling was trouble-free and a 4½ inch OD liner was successfully set at 16,570 feet.

PETROTONE was used to treat this oil mud to eliminate the possibility of any settling of BAROID* at the high bottom-hole temperature. DURATONE controlled filtration at zero API.

Baroid Oil Muds, product of Baroid research and engineering, save your drilling and completion dollars . . . keep your drilling program on schedule. For more information on the unique properties and flexibility of Baroid Oil Muds, write for Product Data Sheets.

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*INVERMUL, emulsifier; PETROTONE, suspending agent; and BAROID, weight material; are Registered Trademarks of Baroid Division National Lead Company.
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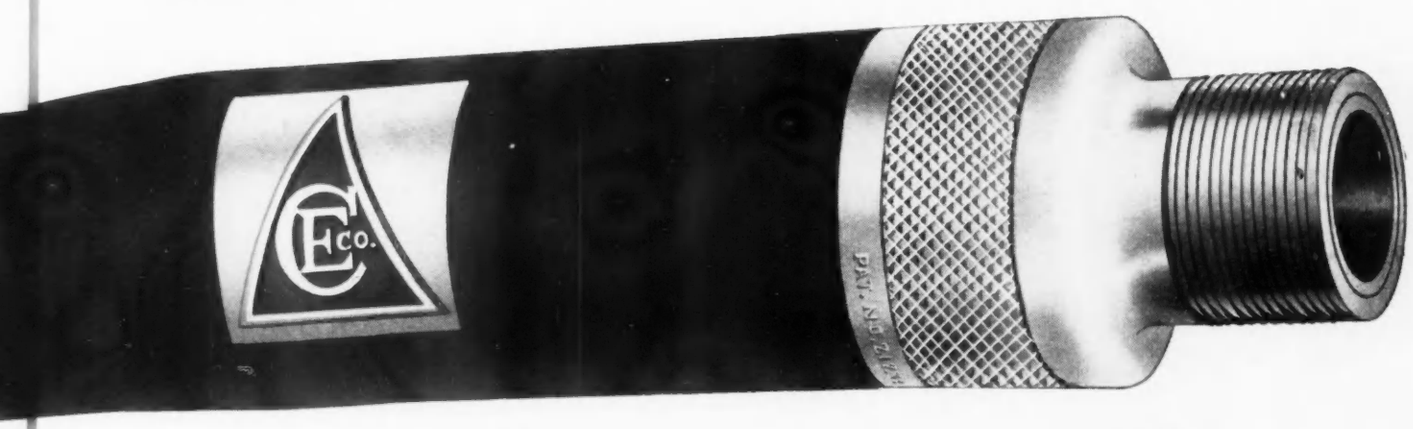

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Here's more news. Green Triangle 5-Band Hose costs no more than the former price of the 3-Band Hose. And the 3-Band Hose is now priced no higher than standard API Class C hose . . *an unprecedented bargain.*

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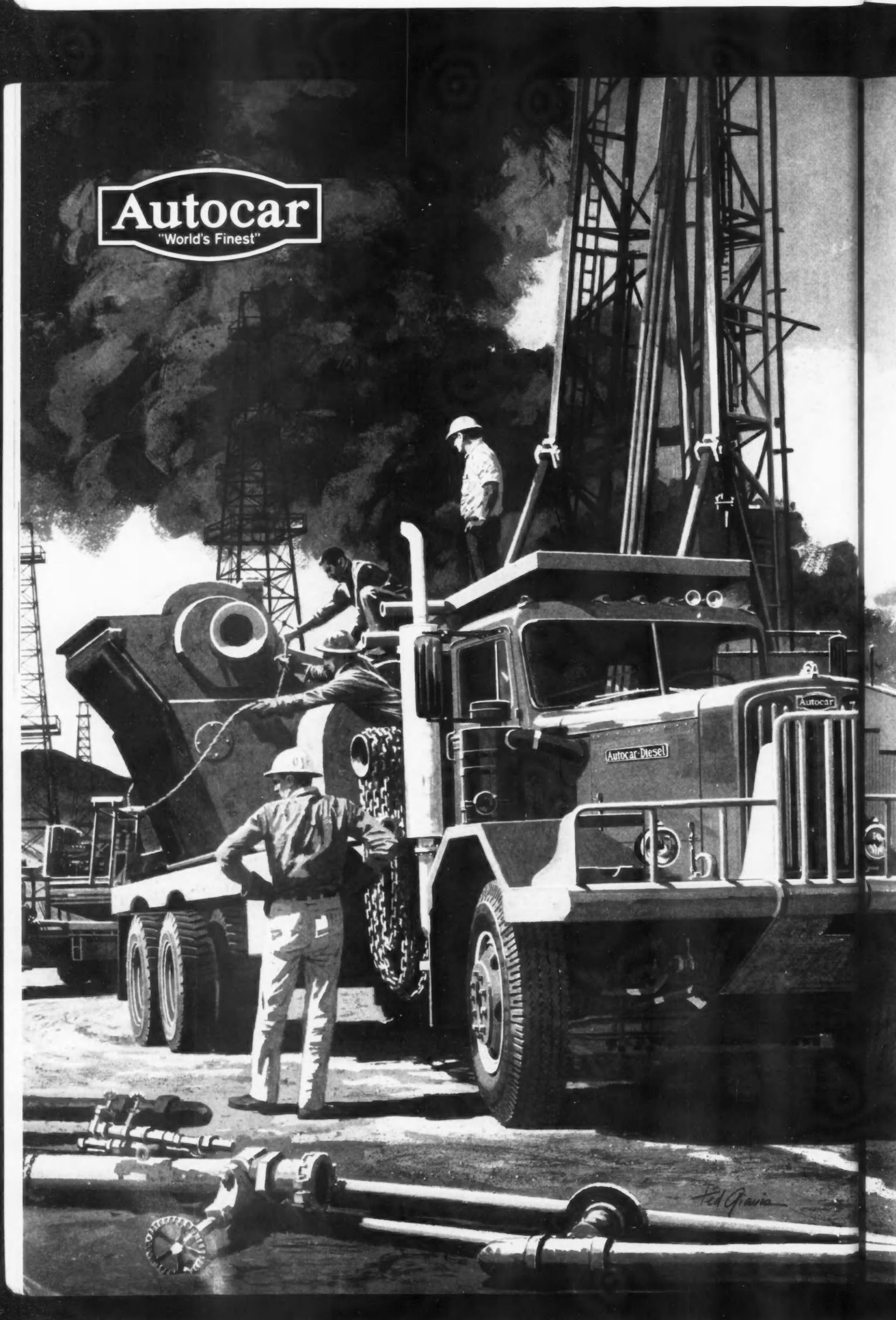
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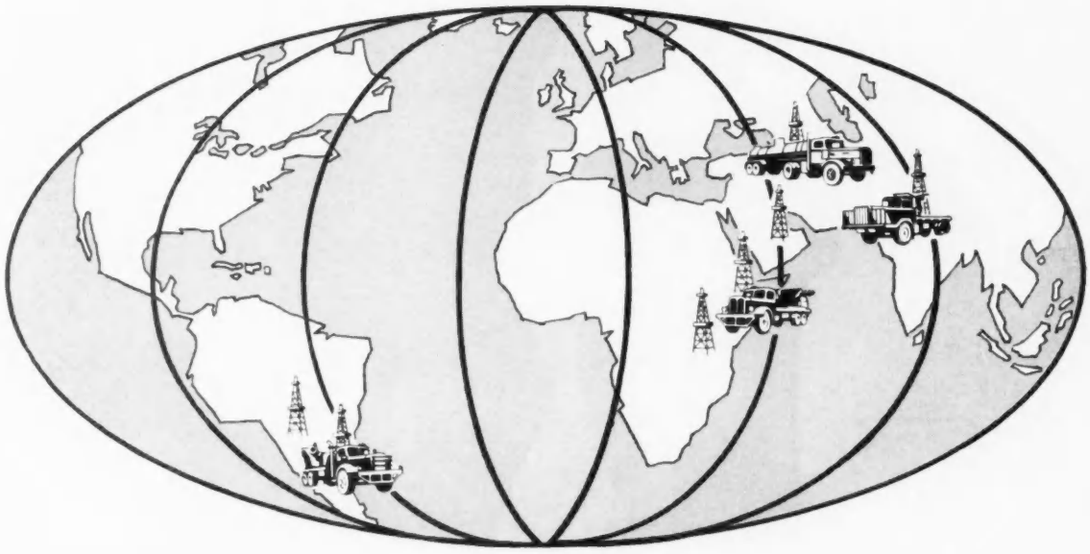

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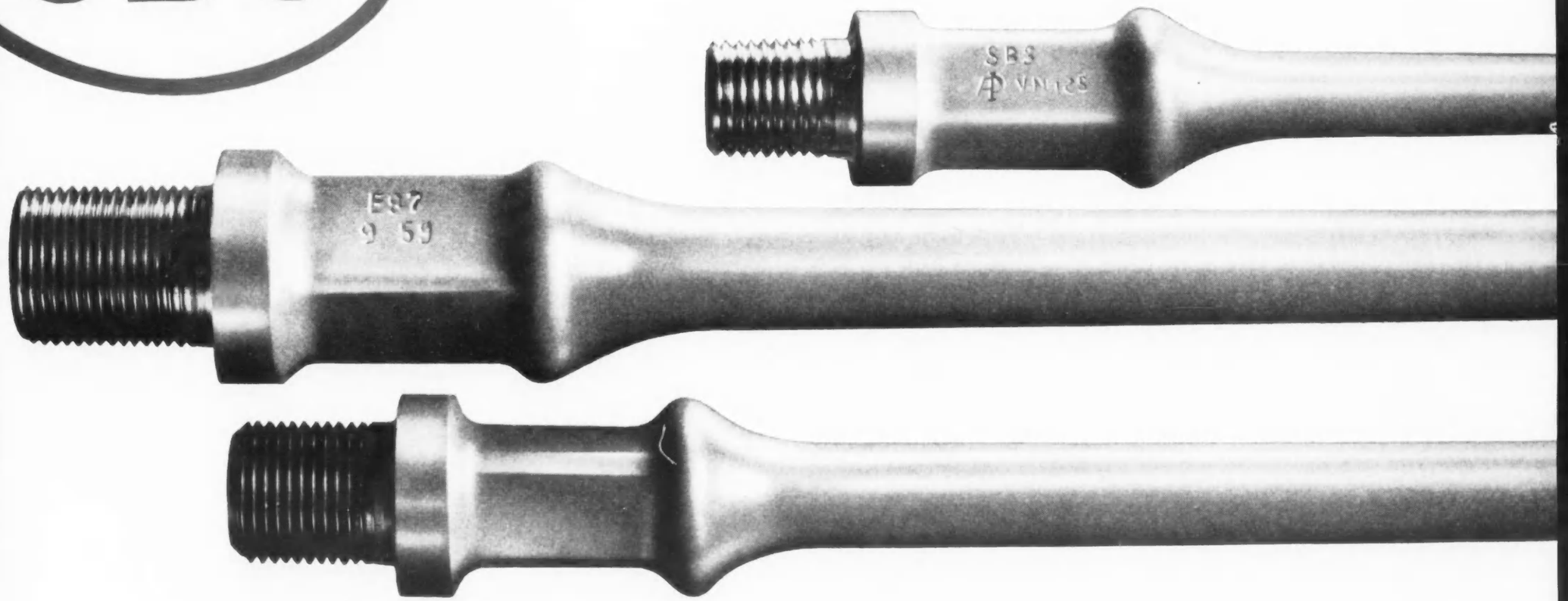

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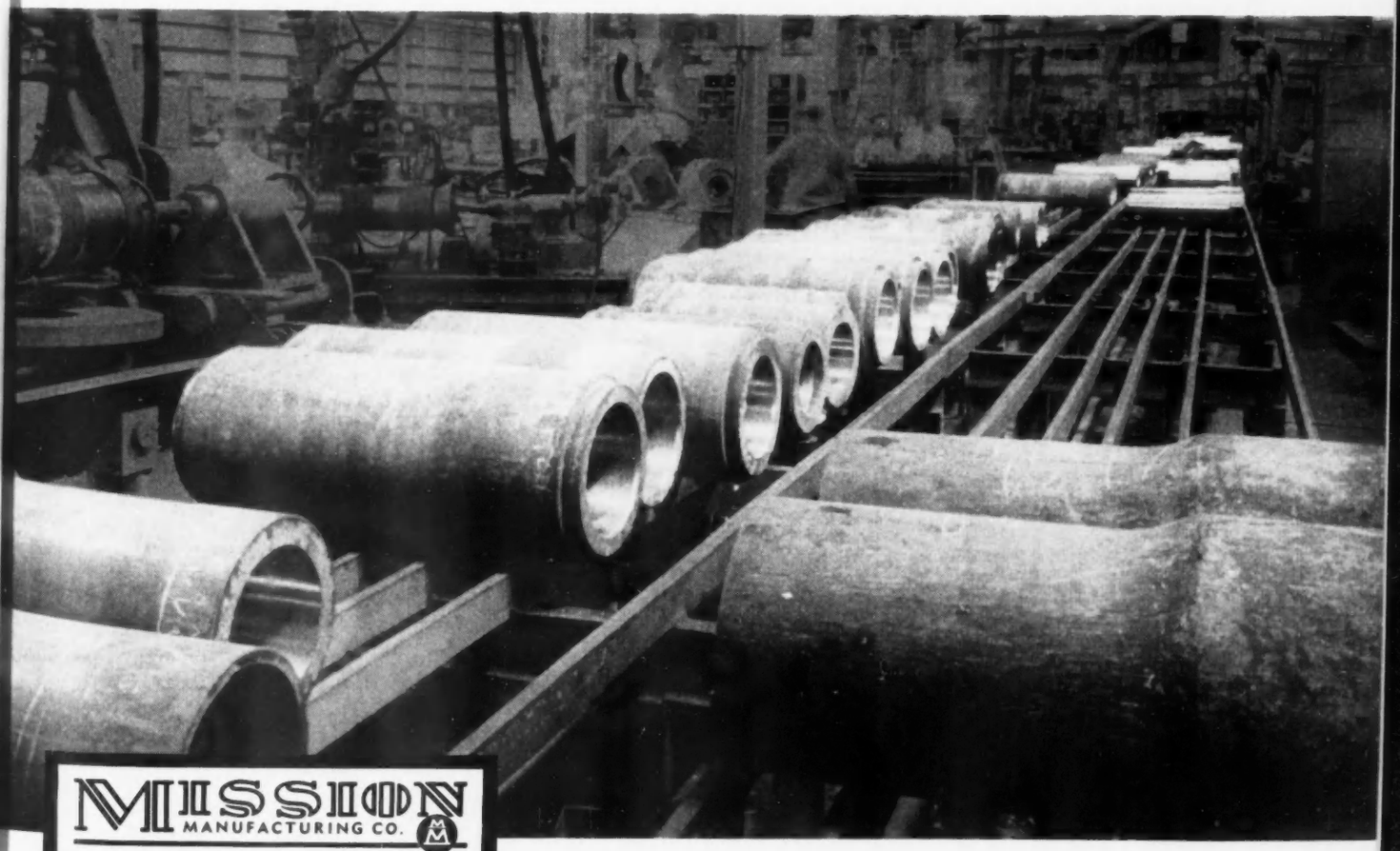

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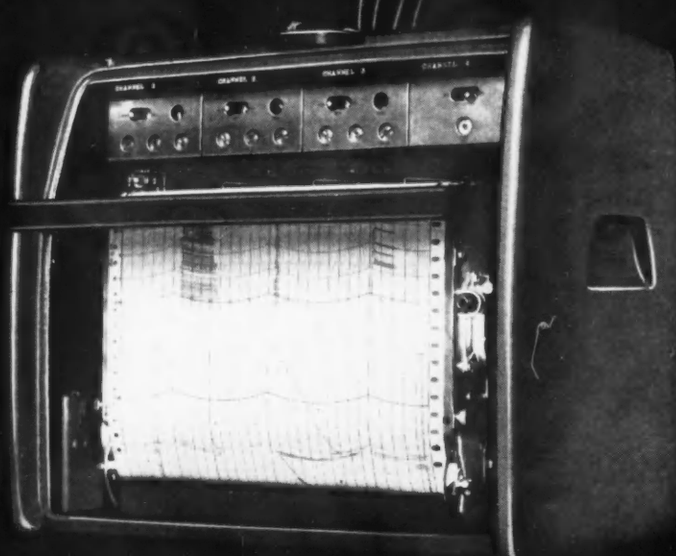

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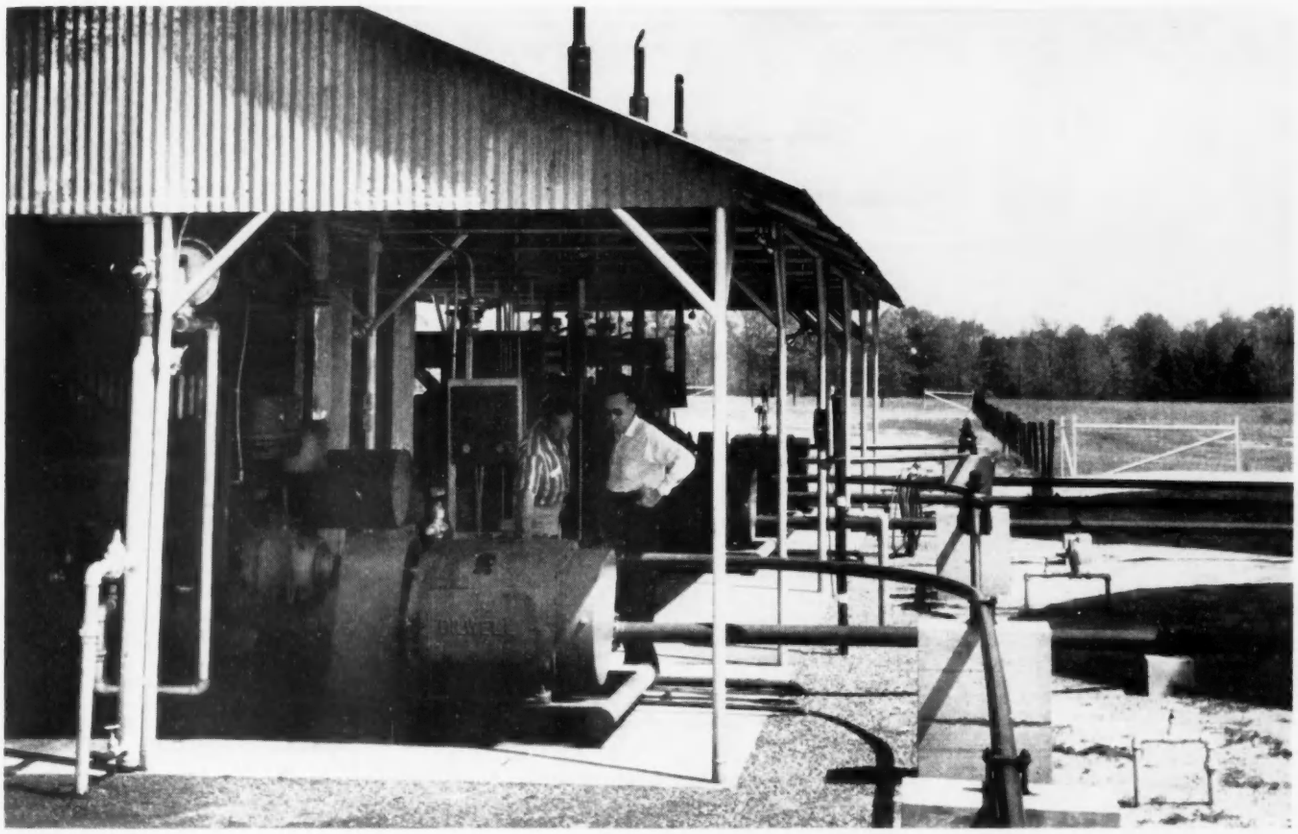

Why "Oilwell" waterflood pumps take it lying down

The pumps in the picture are operating in the New Odom field, and one of them has been pumping 24 hours a day for *eight months* without stopping. Naturally, it's an "Oilwell" pump and its design has a lot to do with its performance.

Every "Oilwell" plunger pump is designed horizontally for eight good reasons: *Low suction* . . . lowness of suction and discharge lines means maximum utilization of suction head and simplifies piping layout. *Less deadweight on crankshaft* . . . eases bearing loads, minimizes vibrational stress in frame and piping. *Simpler thrust transmission* . . . eliminates overhead yoke and pull-rod assemblies. *Cleaner installations* . . . any leakage is confined to frame cradle by gravity. *Natural valve motion* . . . fewer parts needed. *Low center of gravity* . . . reduces vibration that can cause piping stress and fatigue. *Safer maintenance* . . . does away with ladders and neck-craning. *Easier maintenance* . . . greater accessibility.

There's a wide selection of top-performing "Oilwell" Triplex and Quintuplex pumps for waterflood applications, LPG Flood, Pressure Maintenance, Formation Fracturing, Acidizing and Cementing, Salt Water Disposal, or you name it. Whatever your requirements, call on "Oilwell" for complete information and help in the planning stage.

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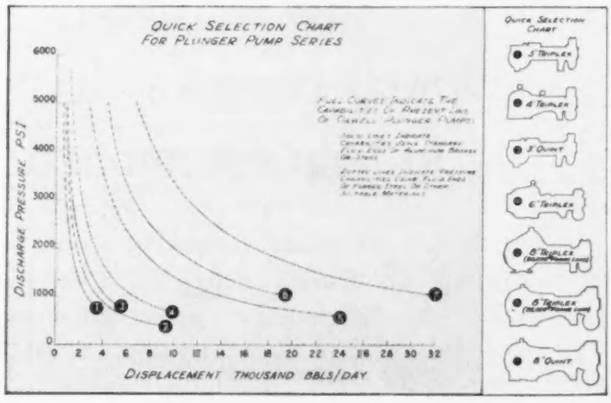

The plunger pump selection manual describes in detail "Oilwell's" complete line of seven primary pumps. Volume-pressure range curves make it a simple matter to pick the pump that's right for the job. Picking plunger sizes is simple, too, because you'll find complete performance data for all plunger sizes available with each size pump.

Write on your company letterhead for a free copy of "Oilwell's" Manual M29-1060. It's one of our ways of making sure that when you buy "Oilwell" equipment, you get a lot more than our product.

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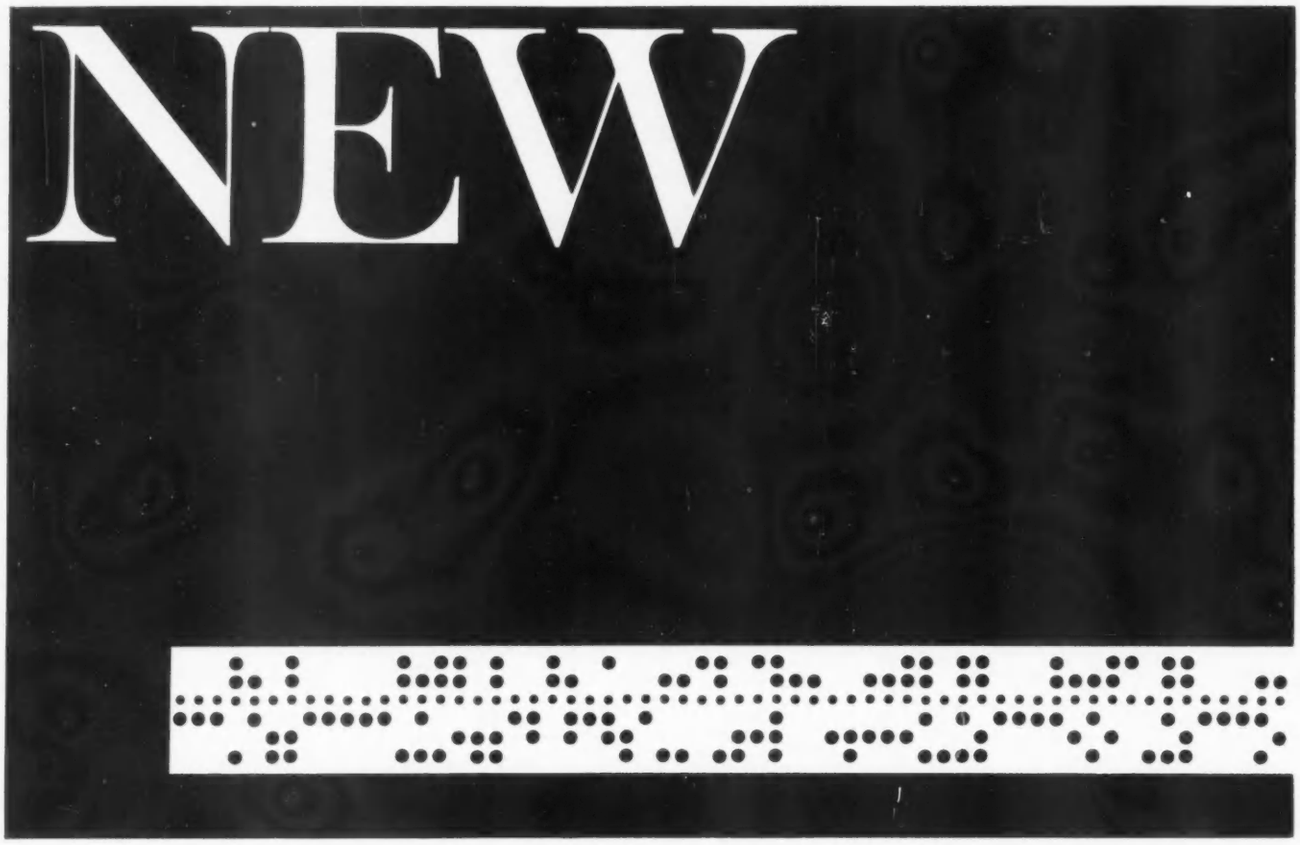

Dowell provides electronic computer calculations to help operators select best frac treatments

Dowell's new electronic computing service is now providing rapid calculations – based on the Frac Guide* – to help operators select fracturing treatments best suited to their needs and available funds. This new service by Dowell costs you nothing extra, yet it offers operators new opportunities for greater profits from fracturing.

The computer provides calculations comparing the effects of different fracturing fluids, injection rates and propping agents for a given set of well conditions.

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The big advantage of Dowell's computing service lies in speed of calculations. Until now, it took an engineer something like a full day to calculate a single treatment with only a few variables. The computer requires less than ten minutes. This, coupled with Dowell's nation-wide teletype system, makes it possible to provide customers with many calculations quickly – usually in only a few hours.

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Again, Dowell is helping operators improve fracturing results. Again, there is no extra cost. Ask for full information. Dowell services and products are offered in North and South America, Europe and North Africa. Dowell, Tulsa 1, Oklahoma.

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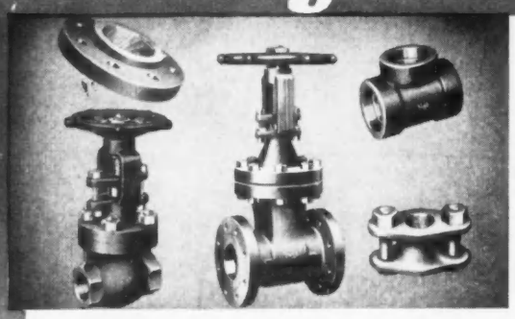

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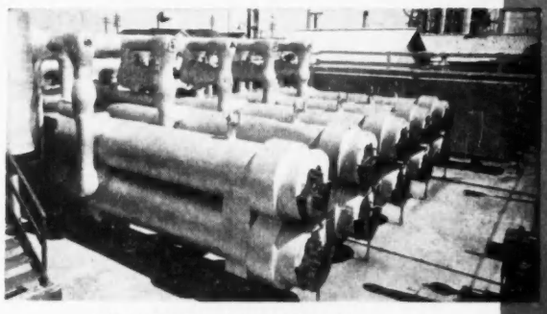

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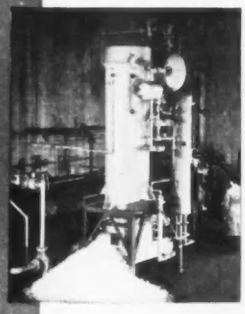

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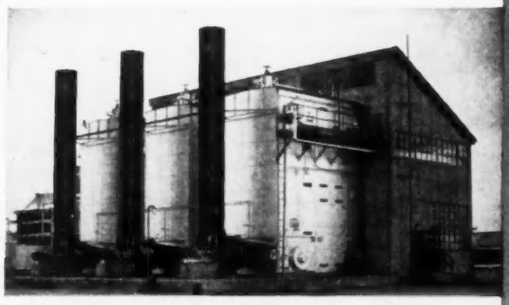

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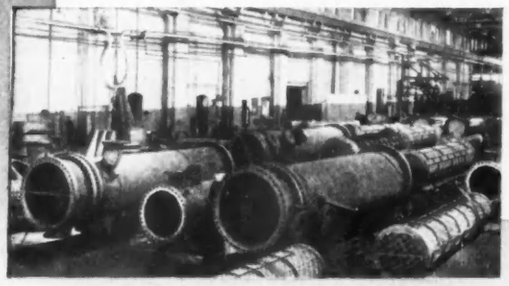

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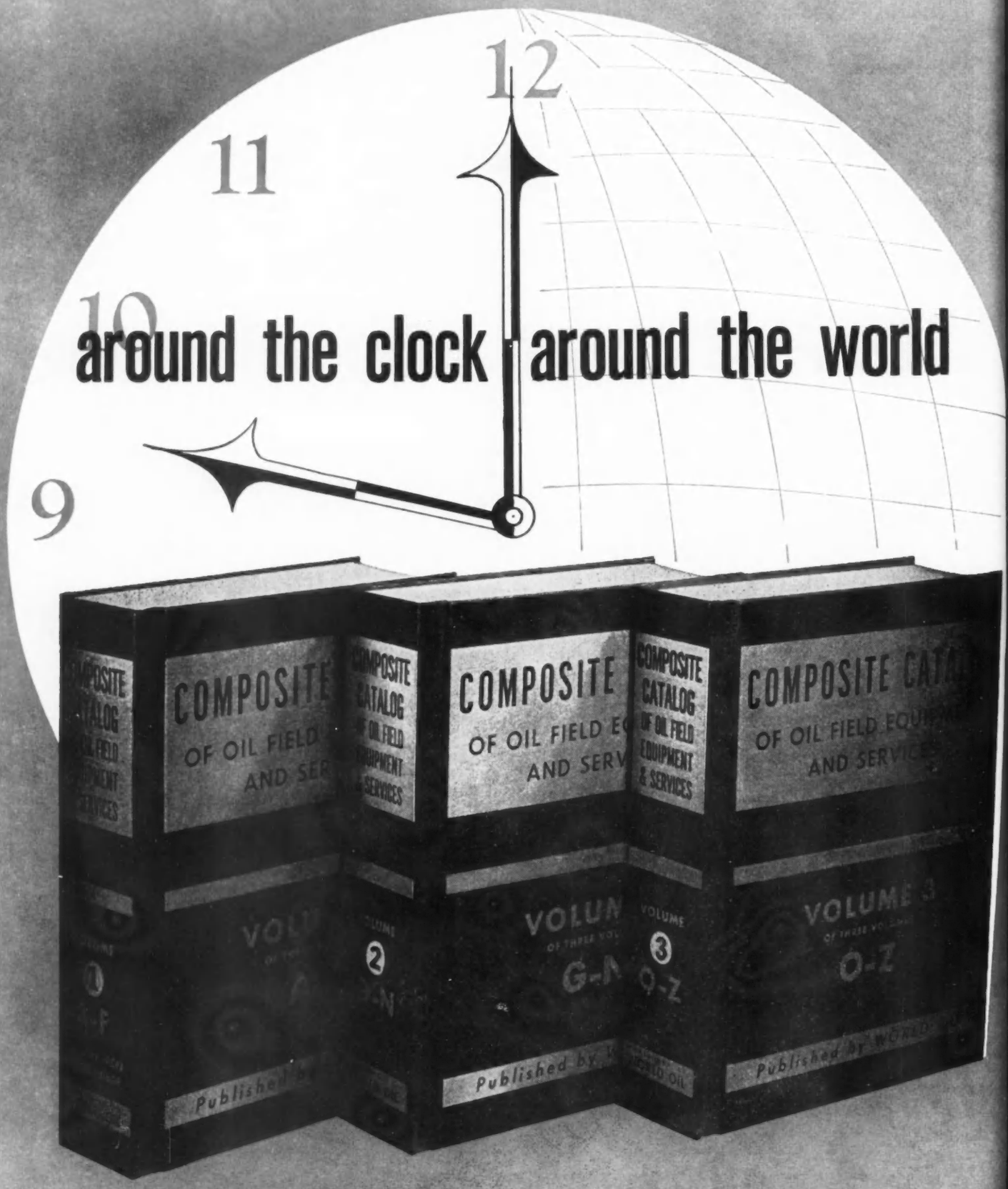

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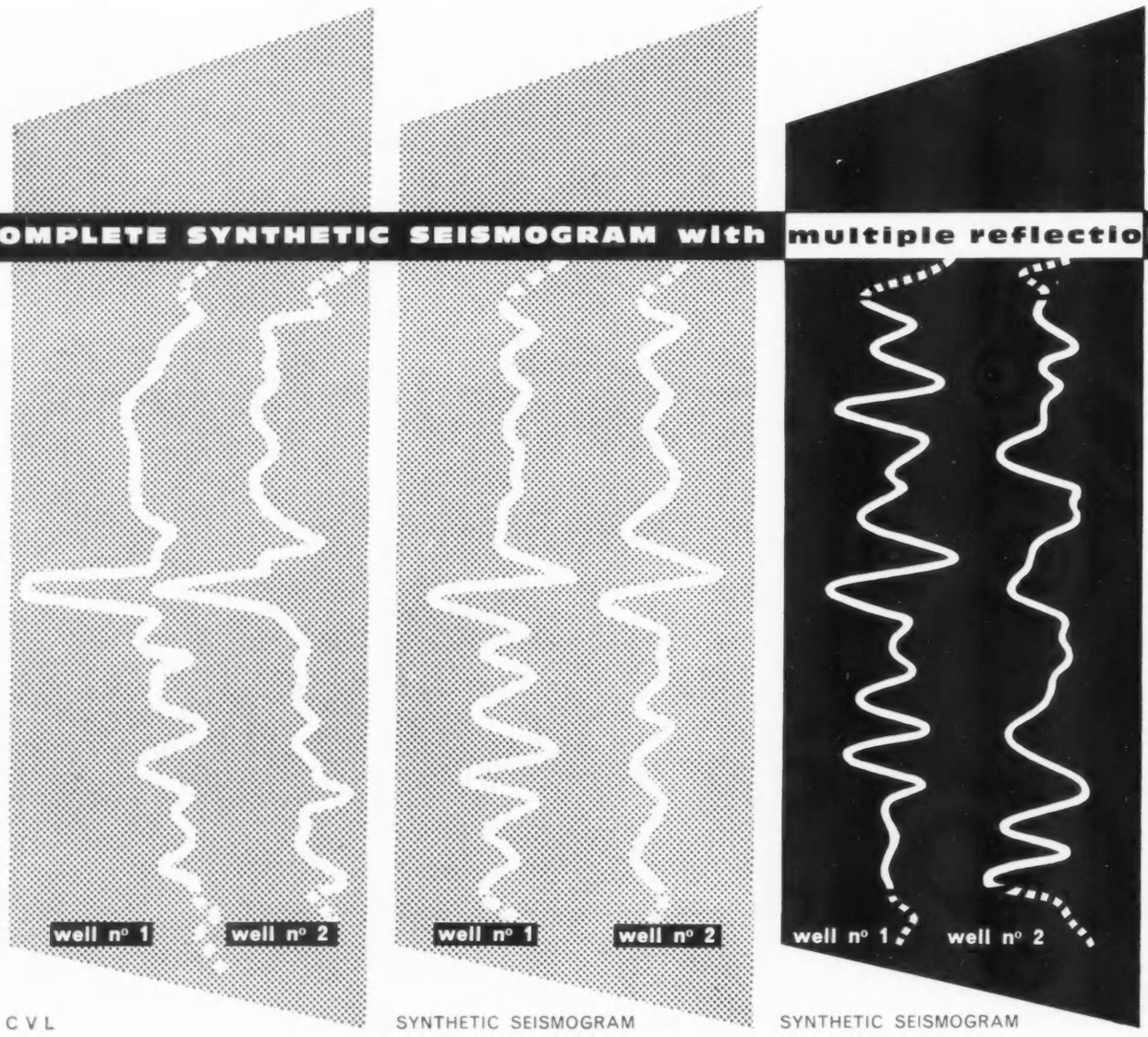
A NEW METHOD OF IMPROVING THE PRESENTATION AND THE INTERPRETATION OF SEISMIC RECORDS

THE COMPLETE SYNTHETIC SEISMOGRAM with multiple reflections



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SYNTHETIC SEISMOGRAM WITHOUT MULTIPLES

SYNTHETIC SEISMOGRAM WITH MULTIPLES

What geological and geophysical information can be obtained after synthetic seismograms are examined and are compared with the actual records ?

The synthetic seismograms make it possible to ascertain the existence and the quality of the horizons which may be used as good markers

The synthetic seismogram leads to improvements of the field techniques: automatic gain control and filtering

The synthetic seismograms are conducive to a more complete and more acurate interpretation

Using the synthetic seismogram your past and present surveys can attain their full value

The cost of a synthetic seismogram with multiple reflections varies with the depth logged : 20 to 25 % of the cost of the logging operations proper

For a borehole of average depth, this cost is no higher than that of one kilometer of seismic profile

YOU TOO WILL BENEFIT FROM THE USE OF THIS NEW GEOPHYSICAL TOOL

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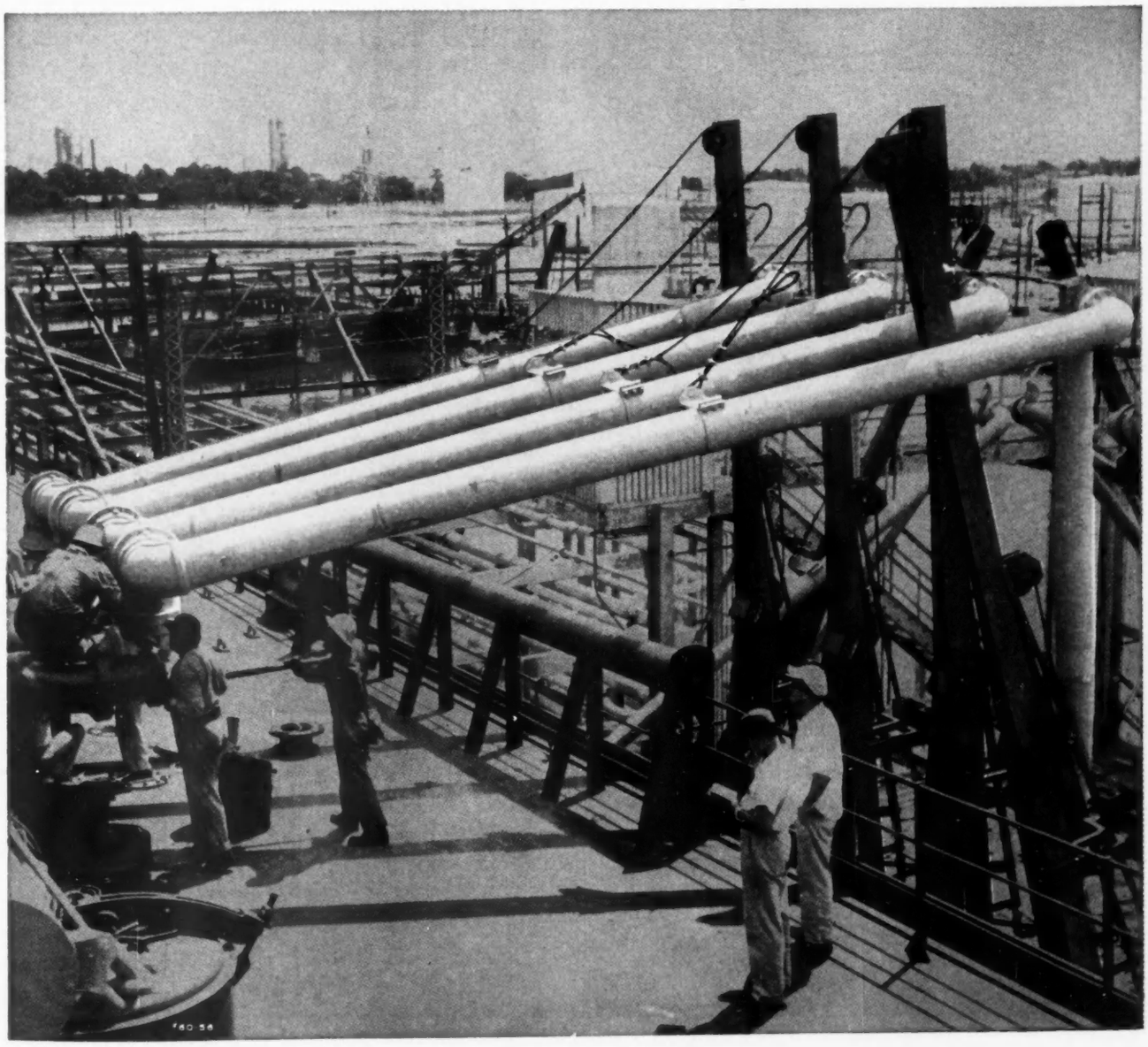

UNIBOLT PRESSUREMATIC WING VALVE

stands guard around the clock . . . and permits choke changing, too

The new UNIBOLT Pressurematic Wing Valve is an adaptation of the tried and proven UNIBOLT Adjustable Wing Valve with an added automatic closing feature. (Any Adjustable Wing Valves now in Christmas tree and other services may be readily converted to "Pressurematics" by replacing the standard stem/bonnet assembly with the new automatic assembly.)

Heretofore, in order to protect a well against broken flowlines and similar mechanical failures that would permit the well to flow wild, an automatic "high-low" valve has been installed in the manifold beyond the wing valve. Now, a single Pressurematic Valve not only safeguards the well against these hazards but also serves as a fine, easy-operable wing valve.

NO SPRINGS—The design is simple and trouble-free.

PRESSURE SURGE OR DROP CLOSES VALVE—Once the well head and flowline pressures are established, it is an easy matter to determine the automatic operating range of this valve. Then, when pressures rise or fall beyond predetermined limits, the valve closes instantly, automatically.

CLOSES EASILY BY HAND FOR CHOKE CHANGING—Unlike all other "high-low" safety valves, the Pressurematic Valve is an excellent Christmas tree wing valve. A few turns of the handwheel closes it for choke changing. Then, the valve is opened and set for automatic operation by further manipulation of the handwheel.

IT SAVES YOU MONEY—This combination automatic shut-off and wing valve costs little more than the price of a good wing valve or a conventional "high-low" valve alone.

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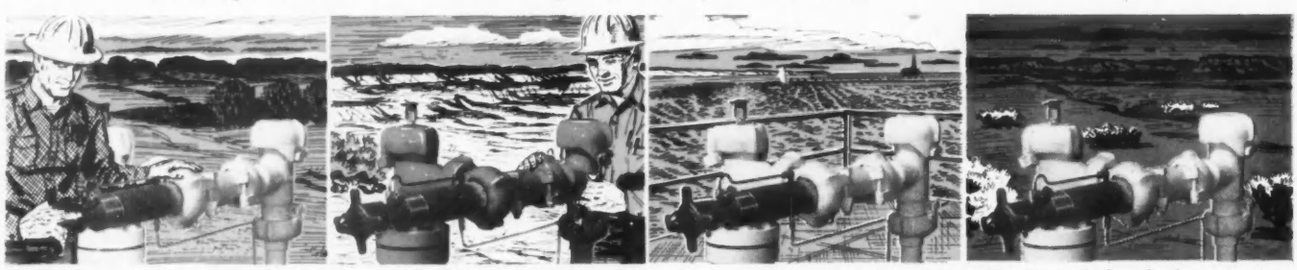

As a wing valve, it opens and closes manually for choke changing. Set for automatic operation, it provides 'round the clock protection.

"The oil business is a growth business. The world's need for oil and the things which come from oil is insatiable, and we see no end to a climbing demand. Companies with first-class physical, financial, and human resources, and a dynamic confidence in the future, will share fully and profitably in the great opportunities ahead."

–M. J. Rathbone, President

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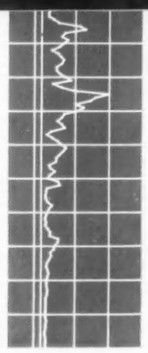

Two men...the inspiration for six thousand

OIL INDUSTRY PROGRESS HAS BEEN MARKED BY MEN WITH THE COURAGE TO RISK FAILURE . . . AND THE KNOWLEDGE, IMAGINATION, AND STAMINA TO ATTAIN SUCCESS.

SCHLUMBERGER PROGRESS HAS BEEN SIMILARLY ACHIEVED. CONRAD AND MARCEL SCHLUMBERGER TOOK THE IDEA OF SUBSURFACE ELECTRICAL MEASUREMENTS AND, WITH KNOWLEDGE, IMAGINATION, DARING, AND PERSEVERANCE, DEVELOPED ONE OF THE MOST VALUABLE CONTRIBUTIONS TO THE EXPLORATION AND PRODUCTION OF OIL — — ELECTRICAL LOGGING. THEY HAD ANOTHER TALENT . . THE ABILITY TO TEACH, TRAIN, AND INSPIRE THEIR CO-WORKERS WITH THE SAME ZEST FOR EXCELLENCE . . . THE TIRELESS SPIRIT OF SERVICE. MORE THAN 6000 SCHLUMBERGER EMPLOYEES THROUGHOUT THE WORLD ARE GUIDED BY A HERITAGE OF LEADERSHIP AS THEY PERFORM THEIR JOBS OF CONTINUALLY IMPROVING AND EXPANDING THEIR SERVICES TO THE OIL INDUSTRY.

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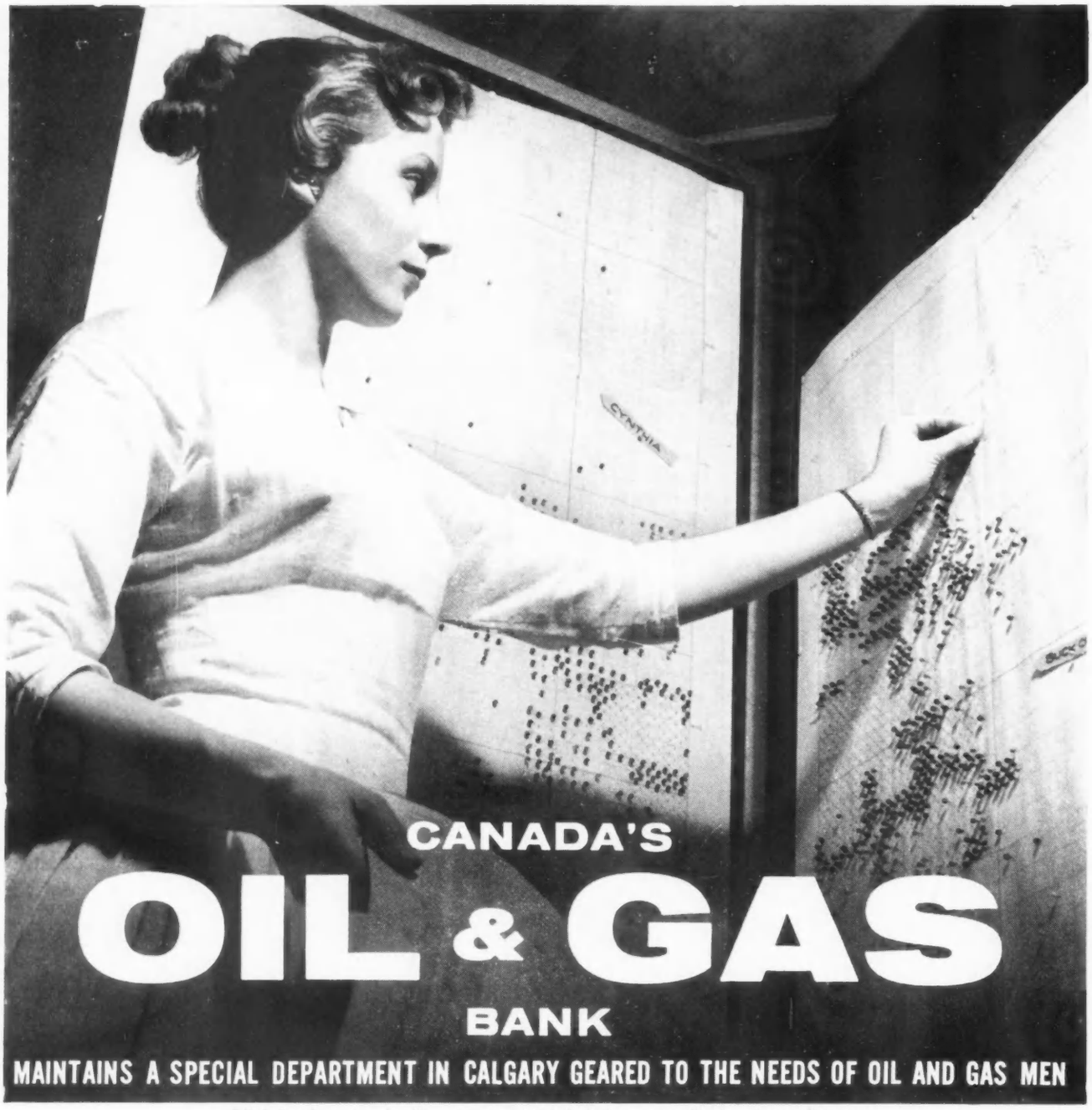

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The officers who staff our Oil and Gas Department in Calgary are "oil bankers" in every sense. By experience and training they are exceptionally well qualified to facilitate and coordinate the many services called for by this fast growing Canadian industry.

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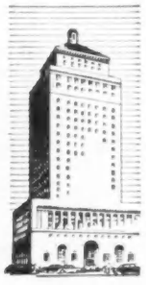

up-to-date information on regulations, tariffs, financing, basic statistics and kindred subjects. For a list of the latest available Oil and Gas Bulletins, write to our Dallas representative, Mr. H. E. McClenaghan, Room 1523, 300 North Ervay St., Dallas 1, Texas; or to The Royal Bank of Canada, Oil and Gas Dept., 409 Eighth Ave. W., Calgary, Alta.

We do not provide information on oil securities.

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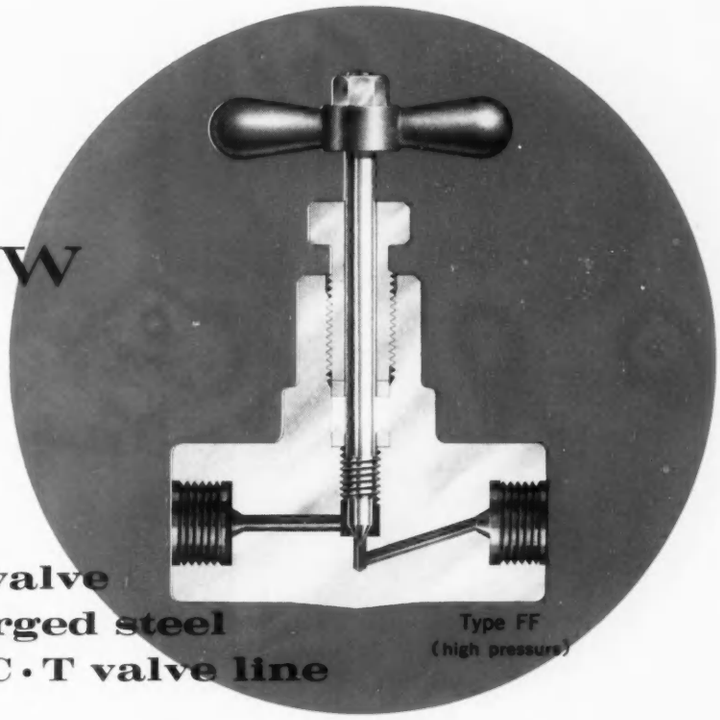
O·C·T adds a tough new NEEDLE VALVE



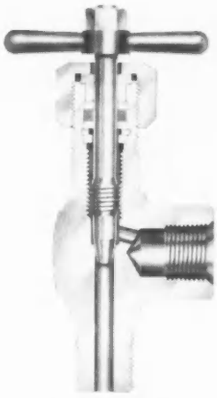
15,000-psi needle valve with one-piece, forged steel body added to O·C·T valve line

This new valve meets proposed new API specifications for use with test ports and pressure gauges. It has Teflon packing for ease of operation and maximum corrosion resistance.

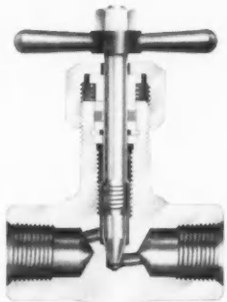
All O•C•T® needle valves have these important features that give you longer valve life and lower valve maintenance costs:

- **One-piece, forged steel bodies for rugged strength and maximum safety**
- **Durable stainless-steel needles**
- **Locking ring to prevent accidentally removing the needle assembly**
- **Needle valves specifically designed for Christmas-tree service**

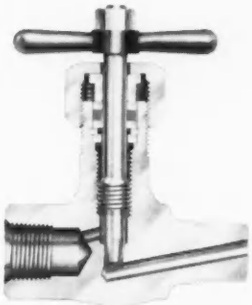
See your O•C•T representative now for further information and prices on the O•C•T line of long-life needle valves.



Type MFL



Type FF



Type MF

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O·C·T

OIL CENTER TOOL CO.

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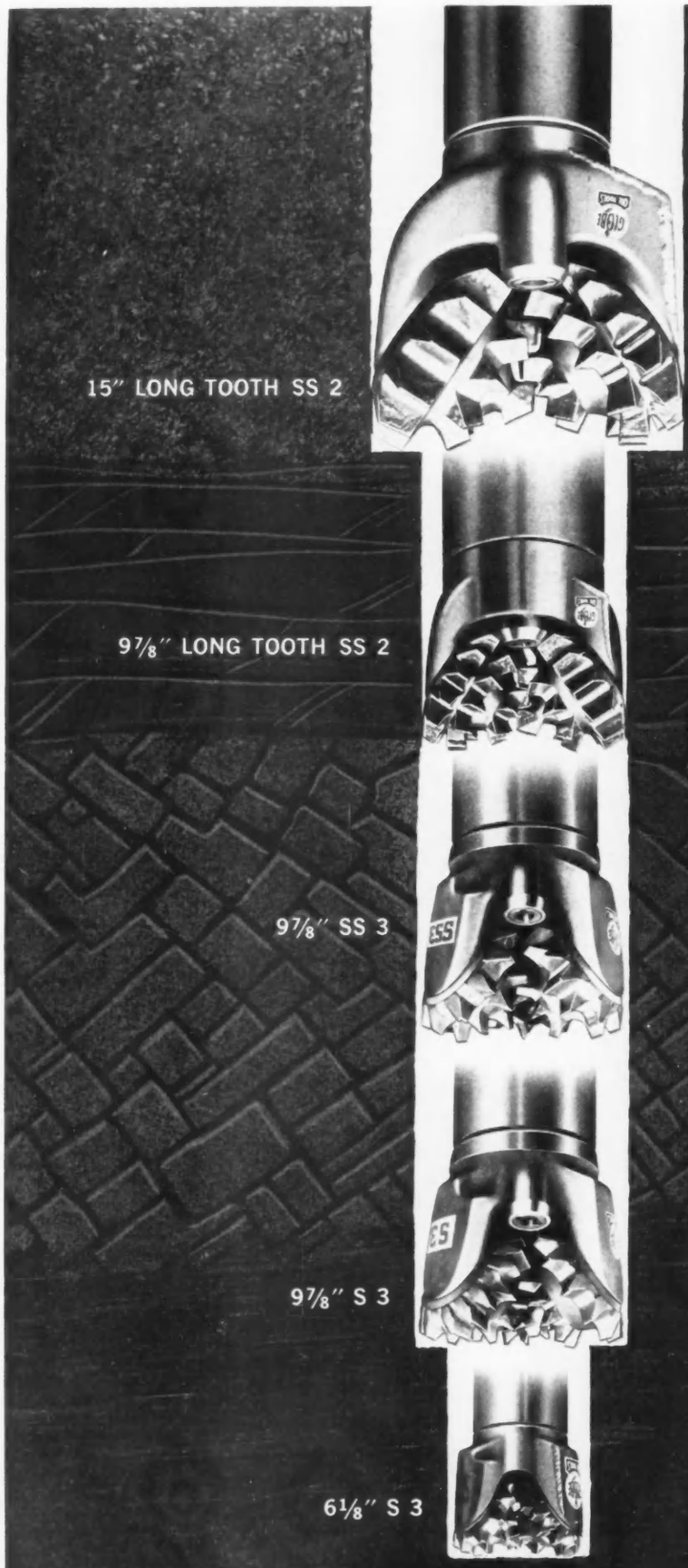

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TO
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FORMATION
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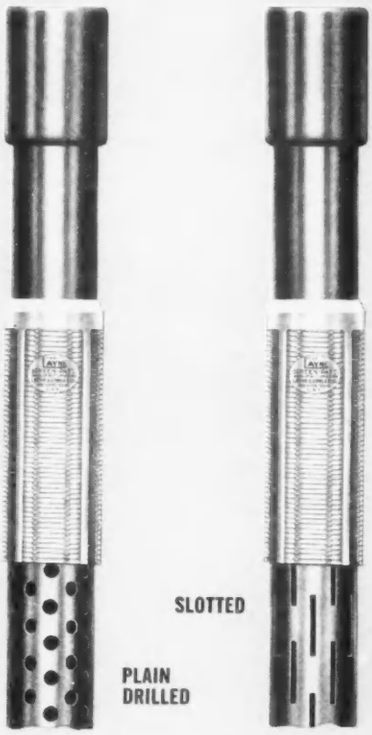
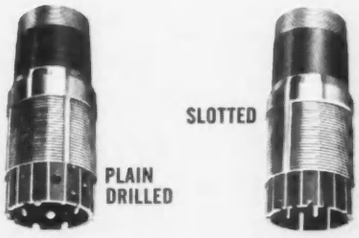


All of the Layne Wire Wrapped Screen, except the "ribbed type," is wrapped directly on the pipe surface for strength and rigidity. The fluid flows laterally following the inverted V shaped channels between the wire wrapping for a natural cleaning action. Two types of pipe perforation, the plain drilled or slotted, are available. Both have excellent performance records and choice between them depends upon conditions encountered.



The Layne "channel ribbed type" screen is identical to the "wrapped on pipe" type except that the wire wrapping is separated from the surface of the pipe by longitudinal bars which are secured by the tension applied through the wire wrappings. The fluid flows longitudinally (up and down the pipe) across the gauge openings of the elevated screen.

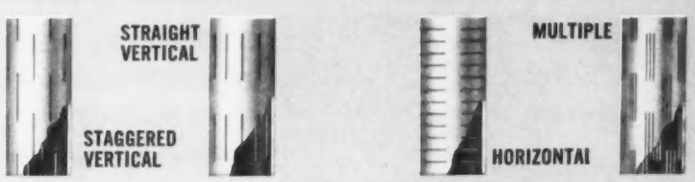
the answer to your sand problems

LAYNE SCREENS

When sand is a problem, then there's one course of action . . . call Layne. Layne screens are precision engineered to your specific needs. Accuracy and uniformity of wire wrappings are guaranteed. Any gauge opening can be furnished from 4/1000 of an inch up on any size or kind of pipe. If the sand is too fine to screen, then the Layne Gravel Packing is the solution. The Layne Engineering Department will determine the exact gauge opening you need if sample of sand is submitted. For complete information on prices and specifications, write or call

THE LAYNE & BOWLER COMPANY
P. O. Box 15274, Houston 20, Texas
ORchard 2-7561

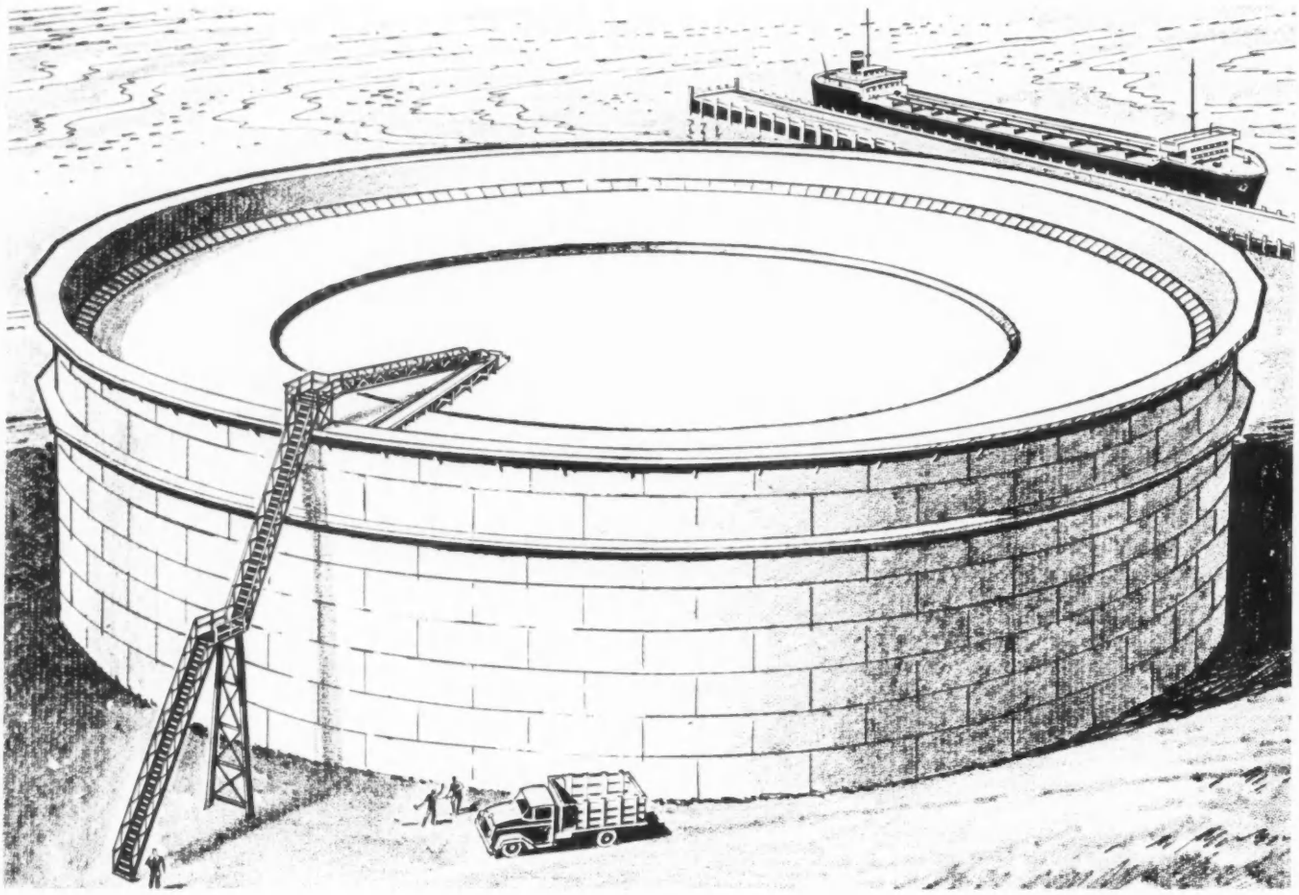
(Not Illustrated: Shuttered or Louvered Type Screens)



SLOTTED PIPE

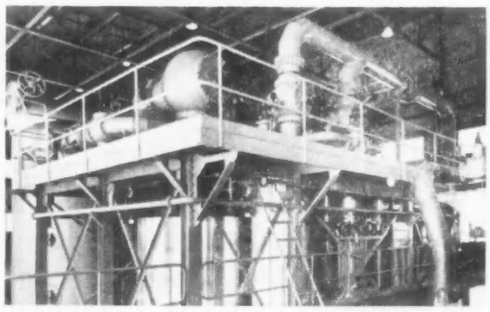
Layne Slotted Pipe is available in four types as shown above. Layne slotted pipe is precision cut with no excess of metal removed — just enough for the opening desired. Width of the openings are the same through the entire pipe wall. Pipe can be furnished in any length or size with standard threads and couplings, or with flush joint threads.

For more data on advertised products, use cards, last page.



Advanced steels that inspire advanced designs

LIQUEFIED METHANE, OXYGEN AND NITROGEN can be moved safely at low temperatures in welded USS 304 stainless steel or 9% nickel steel inner vessels. Steels assure ultra-high purity, minimize heat leaks.



LOW-TEMPERATURE OPERATIONS LIKE THIS liquid oxygen plant use USS low carbon 9% nickel steel for such outstanding characteristics as its moderate first cost, ease of fabrication and excellent notch toughness.

Efficiency and cost-saving were achieved in this new, 600,000-barrel oil tank by specifying USS "T-1"* Constructional Alloy Steel in its construction. Located in Kuwait, on the Arabian Gulf, it stands 64 feet high, is 260 feet in diameter, can fill the largest of the new supertankers in a single stop. The shell consists of six lower 8-foot rings of USS "T-1" Steel, made to 115,000 psi minimum ultimate strength; and a saving of 42% in steel was realized through the use of USS "T-1". Fabricating, shipping and erection costs were similarly reduced, as was the amount of carbon steel needed for two upper rings. This performance and economy story is repeated throughout the world, wherever advanced design specifies the advanced steels from United States Steel Export Company, 100 Church Street, New York 8, New York, U. S. A.

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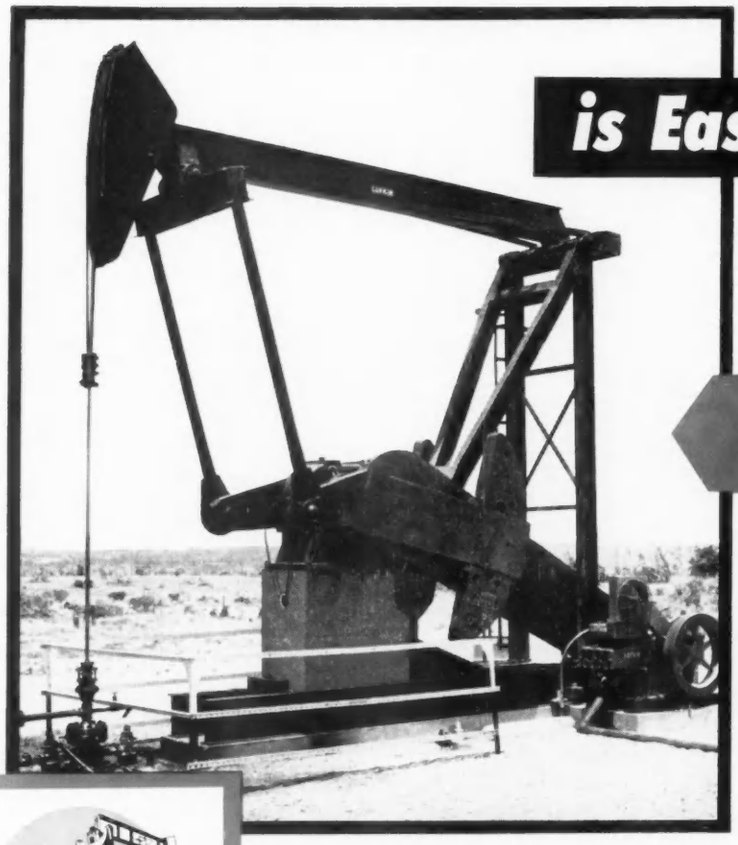
OTHER USS SPECIAL STEELS INCLUDE USS COR-TEN*. . . USS TRI-TEN*. . . USS MAN-TEN*. . . USS CARILLOY*

LUFKIN'S { MARK II Unitorque



is Easy on the Rods!

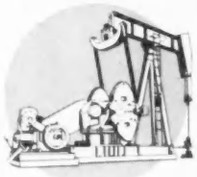
REDUCES ROD LOAD UP TO 10%

IT'S THE POLISHED ROD MOTION THAT DOES IT!

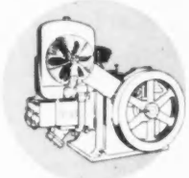
- **SLIM HOLES**
  Where small diameter tubing limits the size of sucker rods, the lower rod stress obtained with the MARK II allows the use of longer rod strings or larger pumps.
- **DEEP HOLES**
  Extends range of sucker rod pumping to depths previously unattainable.
- **BIG VOLUME WELLS**
  Lowered peak load conserves a greater portion of the polished rod capacity for handling additional fluid.

A NEW unit with the same OLD Lufkin Ruggedness and Dependability

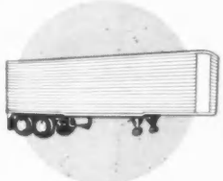
Due to the unique geometry of the MARK II, acceleration at the bottom reversal is decreased as much as 40%. This reduces peak loads up to 10% and tends to avoid shocks, resulting in longer rod life and lower servicing costs.



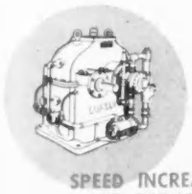
PUMPING UNITS



GAS ENGINES



TRAILERS



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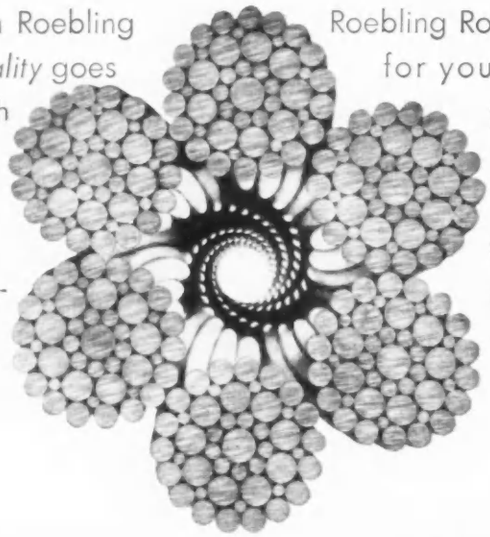

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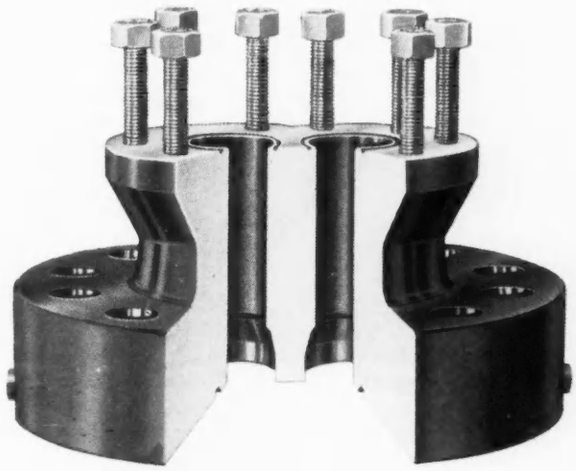
Multi-String Tubing Heads

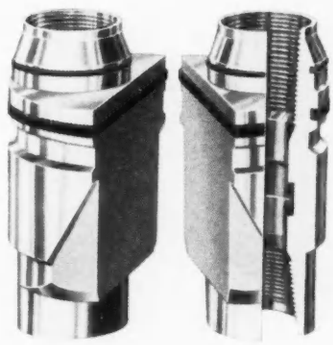
For Maximum Flexibility and Positive Control During All Multiple Completion Operations

From start to finish RECTOR Multi-String Tubing Heads allow full passage of packers and other tools to the oil string. Split hangers are automatically aligned in the head by fixed lugs . . . no guide pin necessary.

Tubing strings are run and landed without removal of blow-out preventers. Positive control of well is maintained by sealing elements on hangers and removable RECTOR-PSI circulating full opening back pressure valves during removal of blow-out preventers and installation of Christmas Tree. A special Rector multi-seal ring on each hanger insures positive steel seal for each tubing string.

Available through your favorite supply store or your Rector representative.





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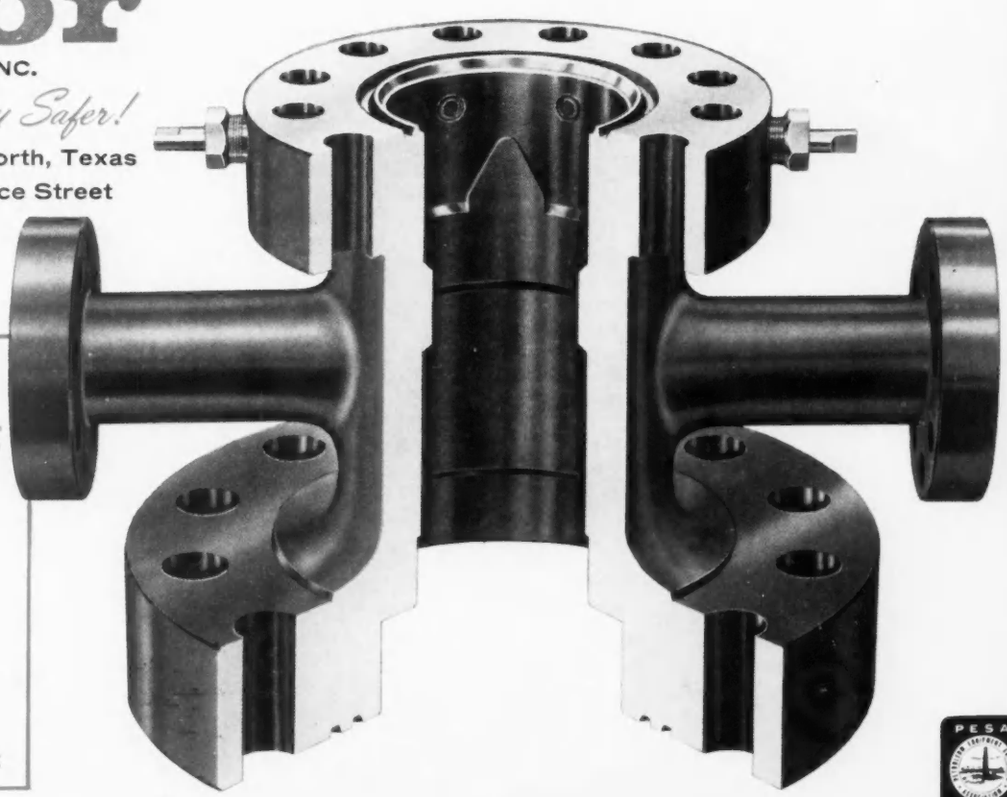

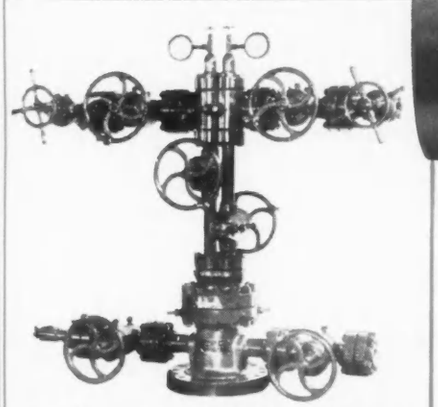

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These three bulletins, covering alloy steel, 416 stainless steel, and 316 stainless steel valves will be sent to you in a binder. Write.

Yes, three great series of needle throttling valves. Great in design and construction. Great in range of corrosion resistant service. Great in range of sizes and patterns.

All three series share the basic design and construction that has set new standards for Marsh Needle Valves.

All give smooth, close regulation and positive shut-off from a few pounds pressure up to high pressures.

All have body and stem guides machined from solid bar stock to provide extra strength and valve life.

All have precision ground stems and long fine-pitched accurately-machined stem threads for micrometer regulation and tight shut-off.

All have deep inlet and outlet threads for tight make-up.

All have special, long-lasting, readily-replaced, special "Marpak" packing incorporating all-but-indestructible Teflon in the stainless steel series.

You see a globe valve representing each series here. Note that the color of the handle identifies the series. Valves come to you individually sealed in strong, transparent plastic packages. In appearance, in operation, in service life you have in these valves the kind of product that only Marsh experience in *both* valve making *and* instrument making could produce.

Globe and angle valves in all three series are available with double female connections in sizes $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$" and 1"—with male inlet and female outlet in sizes $\frac{1}{4}$" and $\frac{1}{2}$". Panel mounted types in all sizes. Write for bulletins.

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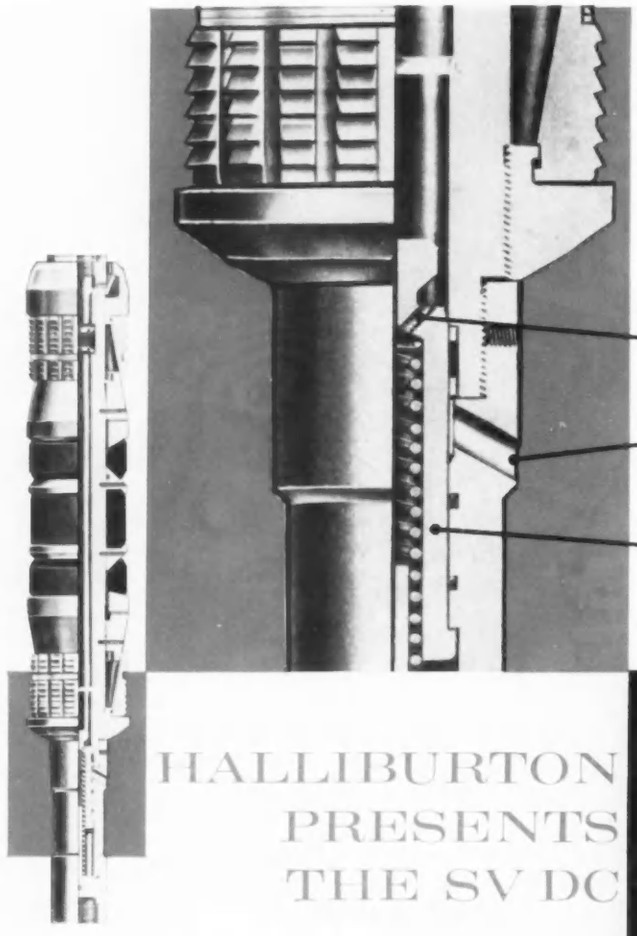

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The Sliding Valve in the Halliburton drillable cast iron SV DC Squeeze Packer provides unique benefits before, during, and after the squeeze job. The pressure balanced sliding valve may be opened or closed *at will* any time simply by raising or lowering the tubing. This permits flow-through of well fluids during run-in on tubing; pressuring-up above or below the packer for testing packer seat and tubing; circulation; squeezing; and reversing out excess cement.

EXCLUSIVE Sliding Valve Features:

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★ Mechanical operation of the sliding valve eliminates necessity of dropping or pumping down sealing ball or plug for shut-off.

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★ Pressure below packer can be released if desired by lowering tubing.

★ Closing valve by lifting tubing a short distance permits testing of tubing under pressure from top to bottom of string without the aid of another device.

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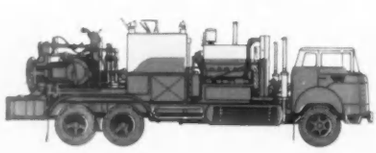

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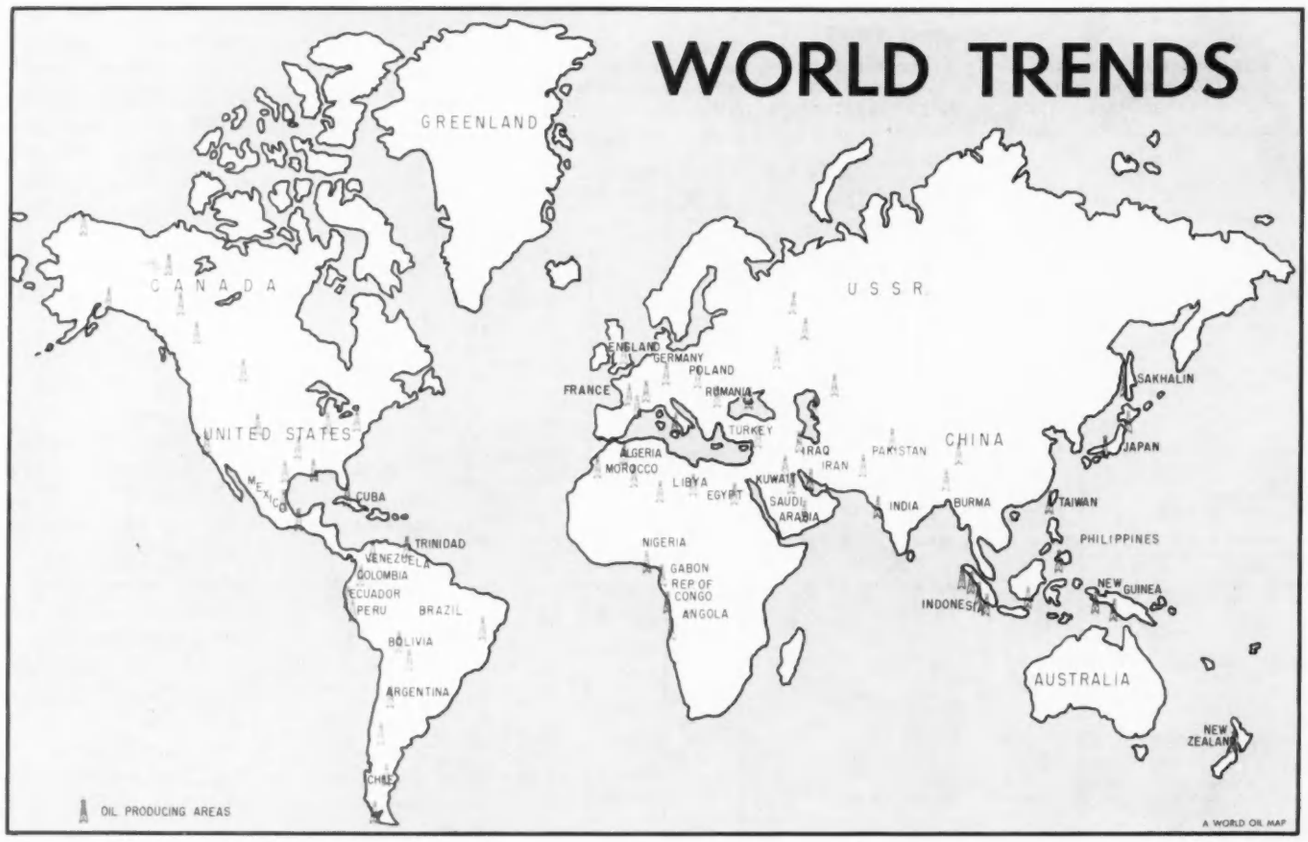


World demand and supply...

better balance achieved in 1960. Oil use still rising

WORLD DEMAND for petroleum in 1961 is forecast at 23,201,000 barrels daily, up 1,160,000 barrels or 5.3 percent over 1960. This includes principally crude petroleum and derivatives and also over 1 million bpd of natural gas liquids, mostly in the United States.

A predominant part of the increase in demand will occur outside the U.S. (Table 1). In those countries, estimated demand of 13,353,000 bpd would be 989,000 bpd or 8 percent above 1960. In the U.S. expected domestic demand of 9,848,000 bpd would be a gain of only 171,000 bpd or 1.8 percent.

All of these anticipated increases would be somewhat smaller than those actually recorded in 1960 over 1959. Worldwide demand in 1960 averaged 22,041,000 barrels daily, an increase of 1,575,000 barrels or 7.7 percent. Demand outside the U.S. was 12,364,000 bpd, up 1,349,000 barrels or 12.2 percent. U.S. domestic demand in 1960 averaged 9,677,000 bpd, a rise of 226,000 barrels or 2.4 percent.

A better balance between supply and demand was achieved in 1960, although supply exceeded demand by 115,900 barrels daily and continued to weaken oil prices (Table 2).

In the U.S., excess demand over domestic supply increased by 183,000 bpd or 12.1 percent to 1,700,000 bpd in 1960 from 1,517,000 bpd in 1959. The increase in excess demand in Canada, which does not have a mandatory imports control program, was milder, increasing by 2.3 percent to 318,200 bpd in 1960 from 311,100 bpd in 1959.

The period 1961-1965 will be critical for the oil industry. World demand for petroleum probably will increase by about 5 percent or over 1.3 million barrels daily each year during that period and reach about 29 million bpd by the end of 1965. Some of the current excess crude oil producing capacity should be relieved by 1965, though almost 29 million bpd probably could be produced now if all shut-in capacity were put on production.

TABLE 1—Demand for Petroleum Rises More Sharply Outside U.S. than in U.S.

(Includes crude oil and natural gas liquids.)

THOUSAND BARRELS DAILY

YEAR	UNITED STATES		OUTSIDE U.S.		WORLD	
	Demand	% Up	Demand	% Up	Demand	% Up
1954	7,752	...	6,650	...	14,402	...
1955	8,460	9.1	7,753	16.6	16,213	12.6
1956	8,779	3.8	8,745	12.8	17,524	8.1
1957	8,797	0.2	9,410	7.6	18,207	3.9
1958	9,065	3.0	10,155	7.9	19,220	5.6
1959	9,451	4.3	11,015	8.5	20,466	6.5
1960	9,677	2.4	12,364	12.2	22,041	7.7
1961 Est.	9,848	1.8	13,353	8.0	23,201	5.3

(See Table 2, World Petroleum Demand and Supply, by Regions, on Page 72)

TABLE 2—World Petroleum Demand and Supply, by Regions, 1960 and 1959

All data from private sources. Crude oil production figures may differ from those in other tables in this issue, which are from various sources. But such differences are not significant.

THOUSANDS OF BARRELS PER DAY

REGION	Domestic Demand	Domestic Supply: Crude Oil	Domestic Supply: Natural Gasoline Etc.	Domestic Supply: Total	Excess Supply Over Demand	Excess Demand Over Supply	% of World: Domestic Demand	% of World: Domestic Supply
1960								
North America	**10,830.6**	**7,827.0**	**986.5**	**8,813.5**	.....	**2,017.1**	**49.2**	**39.8**
United States	9,677.0	7,035.0	942.0	7,977.0	.....	1,700.0	43.9	36.0
Canada	860.2	518.0	24.0	542.0	.....	318.2	3.9	2.5
Other N. America	293.4	274.0	20.5	294.5	1.1	.....	1.4	1.3
South America	**1,431.3**	**3,458.0**	**34.0**	**3,492.0**	**2,060.7**	.....	**6.5**	**15.8**
Venezuela	163.9	2,846.0	20.0	2,866.0	2,702.1	.....	0.7	13.0
Other Caribbean	208.0	268.0	3.8	271.8	63.8	.....	1.0	1.2
Other S. America	1,059.4	344.0	10.2	354.2	.....	705.2	4.8	1.6
Europe excl. USSR	**4,539.6**	**569.0**	**81.9**	**650.9**	.....	**3,888.7**	**20.6**	**2.9**
U.S.S.R.	**2,500.0**	**2,960.0**	**60.0**	**3,020.0**	**520.0**	.....	**11.3**	**13.6**
Afrixa	**495.7**	**278.0**	**6.5**	**284.5**	.....	**211.2**	**2.2**	**1.3**
Middle East	**589.1**	**5,247.0**	.....	**5,247.0**	**4,657.9**	.....	**2.7**	**23.7**
Far East; Oceania	**1,654.7**	**644.0**	**5.0**	**649.0**	.....	**1,005.7**	**7.5**	**2.9**
Total World	**22,041.0**	**20,983.0**	**1,173.9**	**22,156.9**	**115.9**	.....	**100.0**	**100.0**
1959								
North America	**10,556.8**	**7,822.8**	**906.7**	**8,729.5**	.....	**1,827.3**	**51.6**	**42.3**
United States	9,451.0	7,054.0	880.0	7,934.0	.....	1,517.0	46.2	38.4
Canada	828.2	502.1	15.0	517.1	.....	311.1	4.0	2.5
Other N. America	277.6	266.7	11.7	278.4	0.8	.....	1.4	1.4
South America	**1,333.1**	**3,300.6**	**29.7**	**3,330.3**	**1,997.2**	.....	**6.5**	**16.1**
Venezuela	157.2	2,770.6	14.0	2,784.6	2,627.4	.....	0.8	13.5
Other Caribbean	196.1	258.8	5.7	264.5	68.4	.....	0.9	1.3
Other S. America	979.8	271.2	10.0	281.2	.....	698.6	4.8	1.3
Europe excl. USSR	**3,955.4**	**532.2**	**77.2**	**609.4**	.....	**3,346.0**	**19.3**	**3.0**
U.S.S.R.	**2,213.0**	**2,580.0**	**68.0**	**2,648.0**	**435.0**	.....	**10.8**	**12.8**
Africa	**471.2**	**113.3**	**6.5**	**119.8**	.....	**351.4**	**2.3**	**0.6**
Middle East	**539.9**	**4,599.8**	.....	**4,599.8**	**4,059.9**	.....	**2.7**	**22.3**
Far East; Oceania	**1,396.6**	**599.7**	**5.0**	**604.7**	.....	**791.9**	**6.8**	**2.9**
Total World	**20,466.0**	**19,548.4**	**1,093.1**	**20,641.5**	**175.5**	.....	**100.0**	**100.0**

World crude production... to rise

1,221,577 bpd or 6% to 22,166,000 bpd in 1961

WORLD CRUDE OIL PRODUCTION in 1961 is expected to rise to an average of 22,166,000 barrels per day, an increase of 1,221,577 bpd or 5.8 percent above the average of 20,944,423 bpd in 1960. World crude oil output made a strong gain in 1960, increasing 1,464,208 bpd or 7.5 percent above the 1959 average of 19,480,215 bpd. This boost was larger than anticipated.

The rise in 1961 crude output over 1960 was expected to consist of a 1.5 percent increase in the United States to an average of 7,144,000 bpd this year, and an 8 percent increase outside of the U.S. to 15,022,000 barrels daily. Both crude oil production and markets outside the U.S. are growing faster than the generally more fully developed producing industry and markets in the U.S.

The general increase in world crude production is fairly consistent by areas. North America showed a very small increase of 0.1 percent from 7,823,974 bpd in 1959 to 7,830,120 barrels daily last year. In the West Indies, Trinidad is the only sizable producer. Its 1959-60 production boost was 3.2 percent, offsetting a drop in Cuba. South America showed a stronger over-all increase (4.5 percent), sparked by healthy boosts in both Argentine and Brazilian crude outputs.

Western European fields are usually produced at MER due to generally unlimited local markets. A 20 percent boost in West German output which exceeded 100,000 bpd in 1960 (for the first time) was largely responsible for the 9.1 percent increase for Western Europe. However, the Communist countries of eastern Europe showed a 15.8 percent increase, mainly due to Russian successes in recent years and a severe general need for fuel in the communist bloc.

In North Africa, production increased by 189.1 percent to 247,211 barrels daily in 1960, primarily due to completion of the Hassi-Messaoud-Bougie pipe line in Algeria at the end of 1959. In the Middle East, 1960 production increased by 14.6 percent to more than 5 million barrels daily.

In the Far East, 1960 production figures were smaller than those in 1959 because more recent estimates on Red China production indicate that 1959 crude output statistics were overstated.

Oil fields are now being selectively produced to market demand, depending on the gravity, type of product yield and other characteristics of the specific crude. The growing demand for fuel oil in world markets has caused a boost in outputs in certain fields where crudes provide a high fuel oil yield. Safaniya field in Saudi Arabia, Belayim field in Egypt and Wafra field in the Neutral Zone are specific examples.

Newly-developed oil fields in previously non-oil productive nations continue to go on production, further diversifying world crude oil sources. Oil production was expected to begin in Libya by the end of 1961. Small amounts of oil have begun to be produced in the Congo Republic (ex-French Congo), Senegal and The Philippines during the past year.

Crude Production Rising More Sharply Outside U.S. Than in U.S.

YEAR	WORLD: Barrels Daily	WORLD: % Diff. from Prior Year	UNITED STATES: Barrels Daily	UNITED STATES: % Diff. from Prior Year	OUTSIDE U.S.: Barrels Daily	OUTSIDE U.S.: % Diff. from Prior Year
1951	11,733,507	+12.6	6,158,112	+13.9	5,575,395	+11.2
1952	12,380,093	+ 5.5	6,256,382	+ 1.6	6,123,711	+ 9.8
1953	13,145,356	+ 6.2	6,457,759	+ 3.2	6,687,597	+ 9.2
1954	13,744,775	+ 4.6	6,342,433	— 1.8	7,402,342	+10.7
1955	15,413,378	+12.1	6,806,652	+ 7.3	8,606,726	+16.3
1956	16,732,708	+ 8.6	7,151,046	+ 5.1	9,581,662	+11.3
1957	17,887,179	+ 6.9	7,169,592	+ 0.3	10,717,587	+11.8
1958	18,090,947	+ 1.1	6,709,553	— 6.4	11,381,394	+ 6.2
1959	19,480,215	+ 7.7	7,053,671	+ 5.1	12,426,544	+ 9.2
1960	20,944,423	+ 7.5	7,035,336	— 0.3	13,909,087	+11.9
1961 Est.	22,166,000	+ 5.8	7,144,000	+ 1.5	15,022,000	+ 8.0

In the future, crude oil production may reasonably be expected in such areas as Australia, Spanish Sahara, Yemen, Spain, and Spitsbergen. Despite the worldwide superabundance of crude oil and natural gas supplies, each nation with oil possibilities wants to develop a domestic producing industry.

The world total of crude oil wells on production at the end of 1960 was at a new all time peak of 697,620. Almost 600,000 were in the United States, and about 97,643 in other countries. These figures include estimates for Communist countries. No estimates were made for them at the end of 1959. But previous estimates for them indicated world totals of 675,065 producing oil wells at the end of 1958 and 651,284 at the close of 1957. (WORLD OIL, Aug. 15, 1959, P. 102).

The 697,620 producing oil wells at the end of 1960 included 82,500 flowing wells. They constituted 11.8 percent of the total. The U. S. had 67,267 of them, and the rest of the world 15,233. Wells on artificial lift (pumping or on gas lift) totaled 572,632. They included 532,710 in U. S. and 39,922 in other countries.

World Crude Oil Production and Producing Wells, by Countries, 1960 and 1959

(Sources: Private sources or estimates by WORLD OIL.)

Continent and Country	PRODUCING OIL WELLS End of 1960 Flowing	Art. Lift	Total	End of 1959 Total	ANNUAL PRODUCTION (Barrels) 1960	1959	DAILY AVERAGE PRODUCTION (Barrels) 1960	1959	% Diff.
North America	**73,470**	**543,279**	**616,749**	**590,811**	**2,865,824,092**	**2,855,750,686**	**7,830,120**	**7,823,974**	**+ 0.1**
Canada	4,790	9,828	14,618	14,002	191,841,815	184,767,642	524,158	506,213	+ 3.5
Mexico	1,413	741	2,154	2,294	99,049,277	96,393,044	270,626	264,090	+ 2.5
United States	67,267	532,710	599,977	574,515	2,574,933,000	2,574,590,000	7,035,336	7,053,671	— 0.3
West Indies	**850**	**2,408**	**3,258**	**3,471**	**42,518,369**	**41,113,633**	**116,170**	**112,640**	**+ 1.0**
Cuba	.....	110	110	210	161,040	194,847	440	534	— 17.6
Trinidad	850	2,298	3,148	3,261	42,357,329	40,918,786	115,730	112,106	+ 3.2
South America	**4,428**	**16,815**	**21,243**	**21,562**	**1,222,815,117**	**1,166,899,071**	**3,341,040**	**3,196,984**	**+ 4.5**
Argentina	*200	*3,550	3,750	3,804	62,898,000	48,221,081	171,852	132,113	+ 30.1
Bolivia	86	41	127	113	3,574,132	3,170,115	9,765	8,685	+ 12.4
Brazil	*509	*177	*686	562	29,612,676	23,537,430	80,909	64,486	+ 25.5
Chile	125	.....	125	100	7,230,779	6,428,151	19,756	17,611	+ 12.2
Colombia	153	1,990	2,143	2,077	55,770,445	53,574,112	152,378	146,779	+ 3.8
Ecuador	22	1,681	1,703	1,591	2,798,920	2,822,955	7,664	7,734	— 0.9
Peru	333	1,876	2,209	2,904	19,255,034	17,725,847	52,609	48,564	+ 8.3
Venezuela	*3,000	*7,500	*10,500	10,411	1,041,675,131	1,011,419,380	2,846,107	2,771,012	+ 2.7
Western Europe	**878**	**4,379**	**6,170**	**5,077**	**97,501,920**	**89,129,906**	**266,399**	**244,191**	**+ 9.1**
Austria	.....	.....	913	.....	16,619,694	16,945,855	45,409	46,427	— 2.2
France	150	375	525	545	14,116,246	11,712,828	38,569	32,090	+ 20.2
Germany, West	*650	*3,231	3,881	3,745	39,262,169	36,229,582	107,274	99,259	+ 8.1
Italy	25	82	107	100	846,010	657,272	2,312	1,801	+ 28.4
Sicily	.....	83	83	58	12,870,042	10,704,598	35,164	29,328	+ 19.9
Netherlands	53	363	416	372	13,165,583	12,251,462	35,971	33,565	+ 7.2
United Kingdom	.....	245	245	257	622,176	628,309	1,700	1,721	— 1.2
Eastern Europe	.....	.....	***41,575**	.....	**1,188,582,852**	**1,023,462,740**	**3,254,202**	**2,804,007**	**+ 15.8**
Albania	.....	.....	*300	.....	1,567,920	3,201,050 ‖	10,994	8,770	+ 25.4
Bulgaria	.....	.....	*150	.....	1,460,000	1,253,775	3,989	3,435	+ 16.1
Czechoslovakia	.....	.....	*175	.....	929,134	834,025	2,538	2,285	+ 11.1
Germany, East	.....	.....	*10	.....	1,460,000	.....	3,989	.....	.....
Hungary	.....	.....	*530	.....	9,270,450	7,905,000	25,329	21,657	+ 17.0
Poland	.....	.....	*3,000	.....	1,442,448	1,297,575	3,941	3,555	+ 10.9
Rumania	.....	.....	*4,660	.....	85,169,000	85,347,575	232,702	233,829	— 0.5
U.S.S.R. (Russia)	.....	.....	*32,350	.....	1,080,400,000	919,435,000	2,951,912	2,519,000	+ 17.2
Yugoslavia	.....	.....	*400	.....	6,883,900	4,188,740	18,808	11,476	+ 63.9
Africa, Northern	**397**	**195**	**592**	**315**	**90,481,045**	**31,208,780**	**247,211**	**85,504**	**+189.1**
Algeria	270	15	285	65	67,226,388	9,190,714	183,674	25,180	+629.4
Egypt	67	160	227	160	22,559,182	21,305,742	61,637	58,372	+ 5.6
Morocco	60	20	80	90	695,475	712,324	1,900	1,952	— 2.7
Africa, Western	**149**	**12**	**161**	**138**	**13,027,464**	**9,872,037**	**35,640**	**27,047**	**+ 31.6**
Angola	11	.....	11	14	481,045	357,983	1,314	981	+ 33.9
Congo Republic	9	.....	9	.....	388,023	.....	1,060	.....	.....
Gabon	88	12	100	98	5,856,175	5,529,203	16,000	15,149	+ 5.6
Nigeria	40	.....	40	26	6,289,684	3,984,851	17,232	10,917	+ 57.8
Senegal	1	.....	1	.....	12,537	.....	34	.....	.....
Asia, Middle East	**1,096**	**98**	**1,194**	**1,193**	**1,929,789,897**	**1,679,473,274**	**5,272,649**	**4,601,297**	**+ 14.6**
Bahrain	150	.....	150	148	16,500,424	16,473,378	45,083	45,132	— 0.1
Iran	80	22	102	93	390,754,900	338,809,853	1,067,636	928,246	+ 15.0
Iraq	98	1	99	134	354,591,851	311,311,000	968,830	852,907	+ 13.6
Israel	.....	24	24	24	900,000	912,500	2,459	2,500	— 1.6
Kuwait	367	.....	367	319	594,278,196	504,855,244	1,623,711	1,383,165	+ 17.4
Neutral Zone	154	48	202	178	49,830,195	42,438,490	136,148	116,270	+ 17.1
Qatar	51	.....	51	50	63,907,684	62,197,000	174,611	170,403	+ 2.5
Saudi Arabia	196	.....	196	201	456,453,173	399,820,590	1,247,140	1,095,399	+ 13.8
Turkey	.....	3	3	46	2,573,474	2,655,219	7,031	7,275	— 3.4
Asia, Far East	**711**	**3,004**	**3,715**	**4,196**	**26,579,761**	**34,377,817**	**72,623**	**94,186**	**— 22.9**
Burma	*45	*365	410	394	4,065,000	3,982,200	11,107	10,664	+ 4.2
India	*28	*472	*500	550	3,284,850	3,547,800	8,975	9,720	— 7.7
Pakistan	31	48	79	90	2,639,204	2,093,622	7,211	5,736	+ 25.7
China	.....	.....	.....	.....	12,810,000	21,900,000	35,000	60,000	— 41.7
Japan	600	2,082	2,682	3,103	3,730,019	2,856,149	10,191	7,825	+ 30.2
Taiwan	7	27	34	34	14,188	13,046	39	36	+ 8.3
Thailand	.....	*10	*10	25	36,500	75,000	100	205	— 51.2
Oceania	**521**	**2,442**	**2,963**	**2,710**	**186,063,876**	**178,990,497**	**508,369**	**490,385**	**+ 3.7**
Indonesia	414	1,976	2,390	2,159	150,510,300	137,253,191	411,228	376,036	+ 9.4
New Zealand	.....	4	4	4	4,500	4,500	12	12	.....
North Borneo	106	418	524	502	34,004,787	40,071,902	92,909	109,786	— 15.4
Philippines	.....	2	12	.....	1,000	.....	3	.....	.....
West New Guinea	1	42	43	45	1,543,289	1,660,904	4,217	4,551	— 7.3
Total, World	**82,500**	**572,632**	**697,620**	**†629,473**	**7,663,184,393**	**7,110,278,441**	**20,944,423**	**19,480,215**	**+ 7.5**

* Estimate. † Producing oil wells at end of 1959 do not include Communist Countries.

TABLE 1—Crew-Months of Geophysical Exploration for Petroleum in Free World Down in 1960

Source: The 1960 Geophysical Activity Report of the Society of Exploration Geophysicists

METHOD	U. S. A.			Canada			Western Hemisphere			Eastern Hemisphere			World		
	1960	1959	% Diff.	1960	1959	% Diff.	1960	1959	% Diff.	1960	1959	% Diff.	1960	1959	% Diff.
Seismic	4,625	5,097	— 9.3	667	796	— 16.2	6,188	6,988	—11.4	2,725	2,735	— 0.4	8,913	9,723	— 8.3
Gravity	528	548	— 3.6	19	41	— 53.7	807	972	—17.0	564	517	+ 9.1	1,371	1,489	— 7.9
Magnetic	54	51	+ 5.9	.....	1	—100.0	78	52	+50.0	88	109	—19.3	166	161	+ 3.1
Other	.....	.....	.....	.....	3	—100.0	.....	3	—100.0	76	105	—27.6	76	108	—29.6
Total	5,207	5,696	— 8.6	686	841	— 18.4	7,073	8,015	—11.8	3,453	3,466	— 0.4	10,526	11,481	— 8.3

Geophysical activity . . . crews' productivity higher

INCREASED COMPETITION, greater diversification of methods, and higher productivity of crews continue to be evident from tabulations of geophysical activity in the Free World. The grand total of geophysical crew months declined by 8.3 percent to 10,526 in 1960 from 11,481 in 1959, according to the report, "Geophysical Activity 1960" prepared by the Committee on Geophysical Activity of the Society of Exploration Geophysicists. From the peak year 1957, when 13,653 crew months of geophysical activity were recorded, the totals have declined. The 1958 total was 12,601. Recent trends indicated by the 1960 report follow

- Africa is now the second most active region (behind the United States) for geophysical activity, having moved ahead of Europe and South America. Africa recorded 1,201 seismic crew months and 236 party months of gravity, magnetic, and other geophysical work for a total of 1,437 last year, 285 crew months or 24.7 percent more than the 1,152 reported in 1959. Libya was the scene of 566 crew months of geophysical work (481 of it seismic) last year, thus accounting for 39.4 percent of the African total.

As a result, the Western Hemisphere portion of total Free World seismic work dropped from 71.9 percent in 1959 to 69.4 percent last year, while gravity work in the Western Hemisphere slipped from 65.3 percent in 1959 to 58.9 percent in 1960 (Table 2).

TABLE 2—Western Hemisphere in 1960 had 69.4% of Free World's Seismic Prospecting and 58.7% of Gravity Work

(Crew months of work and percent of world total for each area.)

Continent and Country	Seismic		Gravity	
	Crew Mos.	% of Total	Crew Mos.	% of Total
Western Hemisphere	**6,188**	**69.4**	**807**	**58.9**
North America	**5,507**	**61.8**	**607**	**44.3**
United States	4,625	51.9	528	38.5
Canada	667	7.5	19	1.4
Mexico	188	2.1	60	4.4
Cent. America & West Indies	27	0.3	.....	.....
South America	**681**	**7.6**	**200**	**14.6**
Venezuela	8	0.1	1	0.1
Argentina	345	3.9	44	3.2
Colombia	59	0.6	.....	.....
Bolivia	76	0.8	7	0.5
Brazil	133	1.5	108	7.9
Others	60	0.7	40	2.9
Eastern Hemisphere	**2,725**	**30.6**	**564**	**41.1**
Europe	**917**	**10.3**	**118**	**8.6**
Germany	427	4.8	12	0.9
France	127	1.4	24	1.7
Italy & Sicily	183	2.1	.....	.....
Others	180	2.0	82	6.0
Africa	**1,201**	**13.5**	**219**	**16.0**
Middle East	**260**	**2.9**	**63**	**4.5**
Far East	**347**	**3.9**	**164**	**12.0**
Total, World	**8,913**	**100.0**	**1,371**	**100.0**

Source of data: The 1960 Geophysical Activity Report of the Society of Exploration Geophysicists.

- Magnetic exploration, both ground and airborne, increased in 1960. This reverses a downtrend from 400 ground magnetic crew months in 1957 to 226 in 1958 and 161 in 1959. The 1960 total was 166, up 3.1 percent from 1959 (Table 1). The increase was due to gains in South America, the U. S. and Europe, and was in spite of an abrupt drop in the Eastern Hemisphere. *Airborne* magnetometer work increased very strongly to 556,752 line miles in 1960, up 68 percent over 1959. More than half of the 1960 aeromagnetic work was in the U.S. and Africa.

- Offshore seismic activity was rising in the U. S., countering the overall trend in seismic work. A total of 93 offshore seismic crew months in the U. S. in 1960 represented a 40.9 percent boost from the 66 party months in 1959. This activity was light, however, compared to the years 1947, 1948, 1954 and 1955, when more than 300 party months of seismic work was done annually offshore from Louisiana alone. Still, offshore exploration is generally increasing all over the Free World (see WORLD OIL, June 1961, Page 83).

TABLE 3—Geophysical Crew-Months in Free World in 1960, by Countries

Source: The 1960 Geophysical Activity Report of the Society of Exploration Geophysicists

AREA	SEISMIC			GRAVITY			MAGNETIC			OTHERS			ALL		
	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total
World Total	**3,352**	**5,561**	**8,913**	**563**	**808**	**1,371**	**120**	**46**	**166**	**5**	**71**	**76**	**4,040**	**6,486**	**10,526**
Western Hemisphere	**2,726**	**3,462**	**6,188**	**402**	**405**	**807**	**62**	**16**	**78**	.....	.....	.....	**3,190**	**3,883**	**7,073**
South America	**361**	**320**	**681**	**149**	**51**	**200**	**24**	.....	**24**	.....	.....	.....	**534**	**371**	**905**
Argentina	284	61	345	36	8	44	.....	.....	.....	.....	.....	.....	320	69	389
Bolivia	20	56	76	.....	7	7	.....	.....	.....	.....	.....	.....	20	63	83
Brazil	.....	133	133	72	36	108	24	.....	24	.....	.....	.....	96	169	265
Chile	28	24	52	12	.....	12	.....	.....	.....	.....	.....	.....	28	36	64
Colombia	23	36	59	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	36	59
Peru	.....	6	6	28	.....	28	.....	.....	.....	.....	.....	.....	28	6	34
Surinam	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Venezuela	6	2	8	1	.....	1	.....	.....	.....	.....	.....	.....	7	2	9
Central America & West Indies	**3**	**24**	**27**	.....	.....	.....	.....	.....	.....	.....	.....	.....	**3**	**24**	**27**
British Honduras	.....	16	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16	16
Guatemala	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Panama	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Trinidad	3	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	3

(Continued on Page 75)

TABLE 3—Geophysical Crew-Months in Free World in 1960, by Countries

(Continued from Page 74)

Source: The 1960 Geophysical Activity Report of the Society of Exploration Geophysicists

AREA	SEISMIC			GRAVITY			MAGNETIC			OTHERS			ALL		
	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total	Company	Contractor	Total
Mexico	**87**	**101**	**188**	**27**	**33**	**60**	.....	.....	.....	.....	.....	.....	**114**	**134**	**248**
Canada	**296**	**371**	**667**	**6**	**13**	**19**	.....	.....	.....	.....	.....	.....	**302**	**384**	**686**
Alberta	235	216	451	.....	1	1	.....	.....	.....	.....	.....	.....	235	217	452
British Columbia	22	98	120	.....	1	1	.....	.....	.....	.....	.....	.....	22	99	121
Saskatchewan	33	12	45	4	.....	4	.....	.....	.....	.....	.....	.....	37	12	49
N. W. Territories	3	42	45	2	.....	2	.....	.....	.....	.....	.....	.....	5	42	47
Ontario	.....	.....	.....	.....	10	10	.....	.....	.....	.....	.....	.....	.....	10	10
Manitoba	3	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	1	4
Nova Scotia	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Quebec	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	1
United States	**1,979**	**2,646**	**4,625**	**220**	**308**	**528**	**38**	**16**	**54**	.....	.....	.....	**2,237**	**2,970**	**5,207**
Texas	704	968	1,672	66	89	155	16	15	31	.....	.....	.....	786	1,072	1,858
Louisiana	299	489	788	16	12	28	.....	.....	.....	.....	.....	.....	315	501	816
Mississippi	144	217	361	47	7	54	.....	.....	.....	.....	.....	.....	191	224	415
New Mexico	133	126	259	42	6	48	12	.....	12	.....	.....	.....	187	132	319
Utah	98	147	245	10	47	57	.....	.....	.....	.....	.....	.....	108	194	302
Oklahoma	113	138	251	.....	.....	.....	2	.....	2	.....	.....	.....	115	138	253
Wyoming	130	92	222	1	6	7	.....	.....	.....	.....	.....	.....	131	98	229
Colorado	74	72	146	.....	13	13	.....	.....	.....	.....	.....	.....	74	85	159
California	27	101	128	12	6	18	.....	.....	.....	.....	.....	.....	39	107	146
Kansas	86	29	115	4	.....	4	4	.....	4	.....	.....	.....	90	33	123
Michigan	12	1	13	.....	84	84	4	.....	4	.....	.....	.....	16	85	101
Montana	41	46	87	.....	10	10	.....	.....	.....	.....	.....	.....	41	56	97
N. Dakota	43	38	81	.....	.....	.....	.....	.....	.....	.....	.....	.....	43	38	81
Alaska	3	46	49	.....	6	6	.....	1	1	.....	.....	.....	3	53	56
Nebraska	16	15	31	5	7	12	.....	.....	.....	.....	.....	.....	21	22	43
Arizona	8	28	36	.....	2	2	.....	.....	.....	.....	.....	.....	8	30	38
Pennsylvania	2	30	32	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	30	32
Alabama	6	11	17	9	.....	9	.....	.....	.....	.....	.....	.....	15	11	26
Arkansas	5	18	23	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	18	23
West Virginia	6	15	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	15	21
Georgia	5	.....	5	8	.....	8	.....	.....	.....	.....	.....	.....	13	.....	13
South Dakota	6	6	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6	12
Florida	11	.....	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	.....	11
Indiana	.....	1	1	.....	6	6	.....	.....	.....	.....	.....	.....	.....	7	7
Oregon	1	.....	1	.....	6	6	.....	.....	.....	.....	.....	.....	1	6	7
Other	6	12	18	.....	1	1	.....	.....	.....	.....	.....	.....	6	13	19
Eastern Hemisphere	**626**	**2,099**	**2,725**	**161**	**403**	**564**	**58**	**30**	**88**	**5**	**71**	**76**	**850**	**2,603**	**3,453**
Europe	**260**	**657**	**917**	**22**	**96**	**118**	**4**	**15**	**19**	.....	**64**	**64**	**286**	**832**	**1,118**
Austria	34	10	44	12	5	17	.....	.....	.....	.....	.....	.....	46	15	61
Belgium	.....	.....	.....	.....	2	2	.....	.....	.....	.....	.....	.....	.....	2	2
Cyprus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
England	11	1	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	1	12
France	19	108	127	.....	24	24	.....	14	14	.....	17	17	19	163	182
Germany	96	331	427	.....	12	12	.....	.....	.....	.....	45	45	96	388	484
Greece	.....	13	13	.....	.....	.....	.....	1	1	.....	.....	.....	.....	14	14
Ireland	.....	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	3
Italy-Sicily	63	120	183	.....	.....	.....	.....	.....	.....	.....	.....	.....	63	120	183
Netherlands	12	9	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	9	21
Portugal	.....	.....	.....	.....	9	9	.....	.....	.....	.....	.....	.....	.....	9	9
Scotland	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Spain	25	51	76	10	44	54	4	.....	4	.....	2	2	39	97	136
Switzerland	.....	10	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	10
Africa	**212**	**989**	**1,201**	**26**	**193**	**219**	**12**	**5**	**17**	.....	.....	.....	**250**	**1,187**	**1,437**
Algeria	12	241	253	2	10	12	.....	.....	.....	.....	.....	.....	14	251	265
Angola	12	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	12
Belgian Congo	6	.....	6	.....	5	5	.....	.....	.....	.....	.....	.....	6	5	11
Cabinda	.....	11	11	.....	5	5	.....	.....	.....	.....	.....	.....	.....	16	16
Congo	.....	9	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	9
Egypt	27	12	39	12	.....	12	12	.....	12	.....	.....	.....	51	12	63
Ethiopia	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Gabon	16	31	47	.....	7	7	.....	.....	.....	.....	.....	.....	16	38	54
Kenya	12	.....	12	.....	8	8	.....	.....	.....	.....	.....	.....	12	8	20
Libya	60	421	481	.....	85	85	.....	.....	.....	.....	.....	.....	60	506	566
Liberia	.....	4	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	4
Morocco	12	8	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	8	20
Mozambique	24	.....	24	.....	5	5	.....	.....	.....	.....	.....	.....	24	5	29
Nigeria	24	91	115	.....	.....	.....	.....	.....	.....	.....	.....	.....	24	91	115
Niger Republic	.....	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	3
Portuguese Guinea	.....	21	21	.....	4	4	.....	.....	.....	.....	.....	.....	.....	25	25
Senegal	7	28	35	.....	2	2	.....	.....	.....	.....	.....	.....	7	30	37
Somalia	.....	21	21	12	12	24	.....	.....	.....	.....	.....	.....	12	33	45
Spanish Guinea	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Spanish Sahara	.....	27	27	.....	35	35	.....	.....	.....	.....	.....	.....	.....	62	62
Sudan	.....	10	10	.....	5	5	.....	5	5	.....	.....	.....	.....	20	20
Tunisia	.....	33	33	.....	10	10	.....	.....	.....	.....	.....	.....	.....	43	43
Other	.....	10	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	10
Middle East	**12**	**248**	**260**	**16**	**47**	**63**	.....	**7**	**7**	.....	**4**	**4**	**28**	**306**	**334**
Aden	.....	4	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	4
Dhofar	.....	15	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	15
Iraq	12	60	72	.....	15	15	.....	.....	.....	.....	.....	.....	12	75	87
Iran	.....	36	36	.....	12	12	.....	.....	.....	.....	4	4	.....	52	52
Israel	.....	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	3
Jordan	.....	6	6	.....	2	2	.....	.....	.....	.....	.....	.....	.....	8	8
Kuwait	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Lebanon	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Neutral Zone	.....	8	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	8
Oman	.....	24	24	.....	6	6	.....	.....	.....	.....	.....	.....	.....	30	30
Saudi Arabia	.....	18	18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18	18
Syria	.....	6	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
Trucial Coast	.....	13	13	.....	6	6	.....	.....	.....	.....	.....	.....	.....	19	19
Turkey	.....	39	39	16	6	22	.....	7	7	.....	.....	.....	16	52	68
Other	.....	8	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	8
Far East and Oceania	**142**	**205**	**347**	**97**	**67**	**164**	**42**	**3**	**45**	**5**	**3**	**8**	**286**	**278**	**564**
Australia	6	87	93	8	11	19	.....	3	3	.....	.....	.....	14	101	115
Burma	.....	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	3
Formosa	.....	22	22	12	.....	12	.....	.....	.....	.....	.....	.....	12	22	34
India	46	8	54	42	.....	42	42	.....	42	1	.....	1	131	8	139
Indonesia*	12	18	30	.....	12	12	.....	.....	.....	.....	1	1	12	31	43
Japan	54	.....	54	29	.....	29	.....	.....	.....	4	2	6	87	2	89
New Zealand	12	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	12
Pakistan	12	32	44	6	10	16	.....	.....	.....	.....	.....	.....	18	42	60
Papua	.....	3	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	3
Philippines	.....	32	32	.....	34	34	.....	.....	.....	.....	.....	.....	.....	66	66

* Original report includes separate breakdown for Sumatra—18 crew months of Seismic work and 12 gravity, all contract.

World crude reserves . . . rise in 1960

by 10 billion barrels to new high of 266 billion

WORLDWIDE PROVED crude oil reserves, recoverable by primary methods, were calculated at 266,249,992,000 barrels at the end of 1960. This was an increase of 10,362,821,000 barrels or 4 percent over the 255,887,171,000 barrels totaled in a similar study at the end of 1959.

Abrupt increases occurred in only a few countries, e.g., Libya, Algeria, Nigeria and Saudi Arabia. Much of the general increase resulted from steady, successful development drilling and minor resulting upward revisions in many countries.

The Middle East continues to dominate the world crude reserves picture, with a total of 162,900,000,000 barrels at the end of 1960, or 61.2 percent of the world total. Middle East reserves increased by about 5 billion barrels last year, by WORLD OIL estimates. Saudi Arabia's reserves have been boosted considerably in official Arabian American Oil Co. estimates, due largely to long extensions made in Safaniya field. If this deposit is continuous with Khafji field in the Neutral Zone to the north, further large increases both in Saudi Arabian and Neutral Zone reserves figures may be expected, considering this one big field alone.

Although pressure maintenance and secondary recovery programs theoretically do not apply to primary reserves, the success of such programs reduces the hazard in making optimistic reserves estimates. Pressure maintenance in such Middle Eastern fields as Abqaiq, Qatif, and Bahrain is proving very successful. Middle Eastern operating companies may make less conservative reserves estimates in the future.

In addition, Middle Eastern governments may place pressure on oil operators to publish more optimistic reserves estimates. Oil exporting countries are considering international oil production prorationing to apply to exports. A basic tenet of such schemes is this: proven reserves of each country would be the main factor governing allowable oil production for export.

African reserves are increasing. Algeria's reserves have been upgraded to 4.6 billion barrels. Libyan reserves were doubled during 1960 to 3 billion barrels. Zelten and Bahi-Dahra fields in the Sirte Basin are probably good for a billion barrels of primary recoverable reserves each. Mabruk field probably has about 500 million barrels. Recent shallow Eocene discoveries, added to Paleocene-Cretaceous reserves found previously in the Sirte Basin, further enhance the Libyan outlook. Raguba field in Block 20, found in late 1960, has at least 500 feet of oil column.

In Nigeria, BP-Shell planned to raise production to 60,000 bpd by the end of 1961, and reserves estimates have been increased.

Proved Crude Oil Reserves in World Were Increased in 1960

Reserves estimated and production figures compiled by WORLD OIL, with aid of oil companies and other sources

CONTINENT AND COUNTRY	RESERVES, YEAR END (Thousand Barrels) 1960	1959	1960 As % of World	PRODUCTION In 1960 Thous. Barrels	As % of World	Ratio 1960 Reserves to Production
North America	**37,749,753**	**37,674,723**	**14.2**	**2,865,824**	**37.4**	**13.2**
Canada	3,678,542	3,497,124	1.4	191,842	2.5	19.2
Mexico	2,458,000	2,458,252	0.9	99,049	1.3	24.8
United States	31,613,211	31,719,347	11.9	2,574,933	33.6	12.3
West Indies	**392,140**	**352,300**	**0.2**	**42,518**	**0.6**	**9.2**
Cuba	2,140	2,300	....	161	....	13.3
Trinidad	390,000	350,000	0.2	42,357	0.6	9.2
South America	**20,413,558**	**19,695,533**	**7.7**	**1,222,815**	**16.0**	**16.7**
Argentina	1,550,000	1,400,000	0.6	62,898	0.8	24.6
Bolivia	125,000	75,000	0.1	3,574	0.1	35.0
Brazil	375,000[1]	260,000	0.1	29,613	0.4	20.8
Chile	60,000	75,000	0.1	7,231	0.1	8.3
Colombia	625,000[1]	650,000	0.2	55,770	0.7	12.6
Ecuador	25,000	25,000	....	2,799	....	8.9
Peru	300,000[2]	335,000	0.1	19,255	0.3	10.4
Venezuela	17,353,558	16,875,533	6.5	1,041,675	13.6	16.7
Western Europe	**1,455,800**	**1,367,010**	**0.5**	**97,502**	**1.3**	**14.9**
Austria	205,000[1]	210,000	0.1	16,620	0.2	15.3
France	185,000	160,000	0.1	14,116	0.2	13.1
Germany, West	489,800	411,010	0.2	39,262	0.5	12.5
Italy	6,000	6,000	....	846	....	7.1
Sicily	340,000	350,000	0.1	12,870	0.2	26.4
Netherlands	225,000	225,000	0.1	13,166	0.2	17.1
United Kingdom	5,000	5,000	....	622	....	8.0
Eastern Europe	**25,364,941**	**24,268,500**	**9.5**	**1,188,583**	**15.5**	**21.3**
Albania	75,000[1]	20,000	....	1,568	....	423.5
Bulgaria	15,330	15,000	....	1,460	....	10.5
Czechoslovakia	10,851	14,000	....	929	....	11.7
Germany, East	.....	500	....	1,460	....	....
Hungary	135,000[1]	150,000	0.1	9,270	0.1	23.0
Poland	25,228	19,000	....	1,443	....	17.5
Rumania	903,532	900,000	0.3	85,169	1.1	10.6
Russia[3]	24,000,000[2]	23,000,000	9.0	1,080,400	14.3	21.8
Yugoslavia	200,000[2]	150,000	0.1	6,884	....	26.5
Africa, Northern	**8,107,000**	**5,107,000**	**3.0**	**90,481**	**1.2**	**89.6**
Algeria	4,600,000	3,000,000	1.7	67,226	0.9	68.4
Egypt Region, UAR	500,000	600,000	0.2	22,559	0.3	26.6
Libya	3,000,000	1,500,000	1.1	.....	....	....
Morocco	7,000	7,000	....	696	....	10.0
Africa, Western	**267,000**	**190,000**	**0.1**	**13,027**	**0.2**	**20.5**
Angola	15,000	15,000	....	481	....	31.2
Congo	2,000	2,000	....	388	....	5.2
Gabon	50,000	63,000	....	5,856	0.1	10.7
Nigeria	200,000	110,000	0.1	6,290	0.1	31.8
Senegal	.....	.....	....	12	....	....
Asia, Middle East	**162,900,000**	**157,946,000**	**61.2**	**1,929,790**	**25.0**	**84.4**
Abu Dhabi	300,000	50,000	0.1	.....	....	....
Bahrain	225,000	170,000	0.1	16,500	0.2	13.6
Iran	22,000,000	22,000,000	8.3	390,755	5.1	56.3
Iraq	24,000,000	23,000,000	9.0	354,592	4.6	67.7
Israel	15,000	16,000	....	900	....	16.7
Kuwait	60,000,000	60,000,000	22.5	594,278	7.6	102.0
Neutral Zone	2,900,000	2,600,000	1.1	49,830	0.7	58.2
Qatar	2,300,000	2,000,000	0.9	63,908	0.8	36.0
Saudi Arabia	51,000,000[2]	48,000,000	19.2	456,453	6.0	111.7
Syria Region, UAR	50,000	50,000	....	.....	....	....
Trucial Coast	50,000	.....	....	.....	....	....
Turkey	60,000	60,000	....	2,574	....	23.3
Asia, Far East	**985,240**	**850,075**	**0.4**	**26,580**	**0.4**	**37.1**
Burma	50,000	45,000	0.1	4,065	0.1	12.3
India	375,000	350,000	0.1	3,285	....	114.2
Pakistan	20,000	20,000	....	2,639	....	7.6
China	500,000	400,000	0.2	12,810	0.2	39.0
Japan	40,000	34,000	....	3,730	0.1	10.7
Taiwan (Formosa)	40	75	....	14	....	2.9
Thailand	200	1,000	....	37	....	5.4
Oceania	**8,614,560**	**8,436,030**	**3.2**	**186,064**	**2.4**	**46.3**
Brunei-Sarawak (North Borneo)	410,000	430,000	0.1	34,005	0.4	12.1
Indonesia	8,200,000	8,000,000	3.1	150,510	2.0	54.5
New Zealand	50	30	....	5	....	10.0
Philippines	10	.....	....	1	....	10.0
West New Guinea	4,500	6,000	....	1,543	....	2.9
Total, World	**266,249,992**	**255,887,171**	**100.0**	**7,663,184**	**100.0**	**34.7**

[1] Figure may be smaller than stated or inferred elsewhere in this issue. [2] Figure may be greater than stated or inferred elsewhere in this issue. [3] Includes Asiatic Russia and Sakhalin Island.

World drilling... activity loses some momentum. Better success ratios foreseen for 1961

DRILLING IN THE FREE WORLD outside the United States and Canada will remain vigorous in 1961 and in the forseeable future, although it is now expected to drop somewhat compared to 1960 completion totals.

There were 5,868 wells completed in the Free World outside the U.S. and Canada in 1960. In 1961, about 5,714 completions are expected, 154 fewer or 2.6 percent less than last year.

Activity retarded. Surplus crude oil and natural gas producing capacity have generally caused development drilling to slacken. Wildcatting is less active for the same reason, and also because much acreage abroad has been at least partially evaluated and dropped.

This acreage was taken by oil companies during the mid-1950's in a competitive scramble to enter such new countries as Turkey, Libya, Algeria, Guatemala, Israel and others, immediately after adoption of favorable oil laws.

Generally, however, better prospects are being drilled now. A higher ratio of producers to dry holes may be expected this year.

Declines indicated. Hence, the outlook for drilling in 1961 in Canada, the U.S., and the Free World outside Canada and the U.S. is uniformly down. These regions were mentioned above in decreasing order of severity of the anticipated declines.

Outlook in Africa. The drilling activity growth in Africa is expected to continue this year but at a slackening rate. Libya is expected to have 180 new wells this year, compared to 131 in 1960. Algerian drilling may stagnate because of political trouble. Drilling in Spanish Sahara is under way, but other African drilling rates may not increase this year.

In South America, drilling in Argentina is expected to remain active and to offset declines in Venezuela and several other countries.

West European drilling may drop below 1,000 completions this year, since West Germany's total may fall below 400 wells in 1961.

Middle Eastern completions in 1961 are expected to match the 1960 total of 261.

In the Far East, an abrupt decline in 1961 completions is expected in Japan and Indonesia.

Drilling in Free World to Remain Active in 1961

COUNTRY (Not Including Communist Countries)	Forecast for 1961		Wells Completed in 1960								Wells Completed in 1959		Wells Drilling at End of 1960
	Wells	% Diff. 1961–1960	Oil	Gas	Dry	Others	Total Wells	% Diff. 1960–1959	Total Footage	Avg. Depth	Wells	Footage	
N. America, excl. U.S.	**3,252**	**— 11.1**	**2,079**	**488**	**1,027**	**65**	**3,659**	**+ 11.0**	**19,163,569**	**5,237**	**3,297**	**16,310,895**	**353**
Canada	2,502	— 13.6	1,573	416	843	65	2,897	+ 1.4	13,896,996	4,797	2,856	13,208,460	208
Mexico	750	— 1.6	*506	*72	184	.....	762	+ 72.8	5,266,573	6,912	441	3,102,435	145
Central America	**7**	**+ 16.7**	.....	.....	**6**	.....	**6**	**— 14.3**	**55,126**	**9,188**	**7**	**51,027**	.....
British Honduras	2	+100.0	.....	.....	.....	.....	.....	—100.0	.....	.....	2	18,622	.....
Costa Rica	.....	—100.0	.....	.....	3	.....	3	+200.0	27,424	9,141	1	6,775	.....
Guatemala	3	.....	.....	.....	3	.....	3	.....	27,702	9,234	3	18,683	.....
Honduras	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	6,947	.....
Panama	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
West Indies	**326**	**+ 0.6**	**270**	**7**	**47**	.....	**324**	**+ 10.6**	**1,452,197**	**4,482**	**293**	**1,511,861**	**26**
Cuba	12	+300.0	.....	.....	3	.....	3	+200.0	7,382	2,460	1	18,906	2
Dominican Republic	4	+100.0	.....	.....	2	.....	2	+100.0	19,925	9,963	1	15,077	4
Puerto Rico	.....	—100.0	.....	.....	4	.....	4	— 69.2	16,938	4,235	13	*31,292	.....
Trinidad	310	— 1.6	270	7	38	.....	315	+ 13.3	1,407,952	4,470	278	1,446,586	20
South America	**2,300**	**+ 2.8**	**1,556**	**53**	**570**	**59**	**2,238**	**+ 14.8**	**13,264,491**	**5,927**	**1,949**	**12,766,235**	**248**
Argentina*	1,200	+ 14.3	765	40	245	.....	1,050	+ 82.0	5,985,000	5,700	577	3,303,753	100
Bolivia	45	+ 4.7	27	.....	16	.....	43	+ 43.3	253,316	5,891	30	189,670	13
Brazil	200	— 14.2	124	.....	109	.....	233	+ 1.7	1,052,741	4,518	229	940,372	55
Chile	60	+ 7.1	28	7	21	.....	56	— 37.8	411,547	7,349	90	620,412	4
Colombia	170	— 1.7	79	5	42	47	173	— 21.0	1,043,692	6,033	219	1,205,382	13
Ecuador	70	— 9.1	66	.....	11	.....	77	+165.5	217,164	2,820	29	105,965	7
Peru	140	— 6.7	125	.....	25	.....	150	+130.8	767,873	5,119	65	284,200	12
Venezuela	415	— 9.0	342	1	101	12	456	— 35.5	3,533,158	7,748	707	6,091,314	44
Western Europe	**954**	**— 10.3**	**527**	**112**	**422**	**3**	**1,064**	**— 3.3**	**5,380,502**	**5,056**	**1,100**	**5,948,609**	**183**
Austria	73	— 22.4	62	12	20	.....	94	+ 14.6	492,522	5,240	82	356,185	13
France	200	— 5.7	73	8	131	.....	212	+ 5.5	1,272,426	6,002	201	1,418,783	25
Germany, West	385	— 14.6	312	13	126	.....	451	— 11.2	2,090,751	4,636	508	2,470,025	80
Great Britain	22	— 24.1	11	1	15	2	29	— 17.2	95,329	3,287	35	135,613	3
Italy	172	+ 2.4	7	69	92	.....	168	+ 1.2	887,855	5,285	166	803,918	47
Sicily	34	— 20.9	23	1	19	.....	43	+ 7.5	227,168	5,283	40	369,150	5
Netherlands	42	— 23.6	39	8	7	1	55	+ 44.7	198,522	3,609	38	220,663	1
Portugal	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	31,770	1
Spain	13	+ 44.4	.....	.....	9	.....	9	— 52.6	88,806	9,867	19	115,000	5
Miscellaneous	11	+266.7	.....	.....	3	.....	3	+ 50.0	27,123	9,041	2	17,766	3
Africa, Northern	**431**	**+ 15.5**	**218**	**15**	**140**	.....	**373**	**+ 49.2**	**2,713,456**	**7,275**	**250**	**1,652,893**	**78**
Algeria	175	— 4.9	124	14	46	.....	184	+ 23.5	1,475,000	8,016	149	1,028,031	33
Egypt	62	+ 17.0	44	.....	9	.....	53	+ 71.0	277,017	5,227	31	184,964	10
Libya	180	+ 37.4	48	1	82	.....	131	+204.7	923,604	7,050	43	343,321	35
Morocco	10	+100.0	2	.....	3	.....	5	— 77.3	37,835	7,567	22	73,545	.....
Spanish Sahara	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tunisia	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	23,032	.....
Africa, Other	**112**	**— 12.5**	**40**	**1**	**87**	.....	**128**	**— 17.4**	**949,388**	**7,417**	**155**	**1,136,375**	**14**
Angola	20	+ 33.3	1	.....	14	.....	15	— 6.3	161,360	10,757	16	132,500	2
Cabinda	12	+ 33.3	.....	.....	9	.....	9	.....	39,667	4,407	.....	.....	.....
Congo Republic	3	— 50.0	1	.....	5	.....	6	— 50.0	31,633	5,272	12	63,454	1
Gabon	20	— 42.9	21	.....	14	.....	35	— 16.7	184,077	5,259	42	192,981	2
Nigeria	35	+ 6.1	17	1	15	.....	33	— 37.7	355,291	10,766	53	537,387	4
Miscellaneous	22	— 26.7	.....	.....	30	.....	30	— 6.2	177,360	5,912	32	210,053	5

* Estimate. † Results unknown. ‡Service wells (water input, gas injections, etc.).

(Continued on Page 78)

Drilling in Free World to Remain Active in 1961 (Continued from Page 77)

COUNTRY (Not Including Communist Countries)	Forecast for 1961		Wells Completed in 1960								Wells Completed in 1959		Wells Drilling at End of 1960
	Wells	% Diff. 1961–1960	Oil	Gas	Dry	Others	Total Wells	% Diff. 1960–1959	Total Footage	Avg. Depth	Wells	Footage	
Middle East	**261**		**170**	**4**	**79**	**8**	**261**	**+ 83.1**	**1,437,976**	**5,509**	**217**	**1,202,810**	**40**
Abu Dhabi	2	+ 50.0	1	.....	.....	.....	1	— 50.0	10,158	10,158	2	16,720	1
Bahrain	1	.....	1	.....	.....	.....	1	.....	3,000	3,000	1	7,675	1
Dhofar	1	— 83.3	.....	.....	6	.....	6	— 25.0	40,340	6,723	8	*38,000	1
Iran	26	+ 30.0	9	1	7	3	20	+ 33.3	195,391	9,766	15	173,641	8
Iraq	20	— 35.5	21	.....	10	.....	31	+ 34.8	257,237	8,299	23	138,459	8
Israel	25	+ 19.0	3	3	15	.....	21	+133.3	107,446	5,116	9	55,615	3
Jordan	.....	—100.0	.....	.....	1	.....	1	— 66.7	12,040	12,040	3	17,250	.....
Kuwait	43	+ 95.5	22	.....	.....	.....	22	— 56.0	103,124	4,687	50	222,254	3
Neutral Zone	85	— 2.3	87	.....	.....	.....	87	+112.2	244,038	2,805	41	109,717	5
Oman	.....	—100.0	.....	.....	2	.....	2	+100.0	16,253	8,127	1	12,661	.....
Qatar	3	— 25.0	2	.....	2	.....	4	+300.0	30,344	7,586	1	13,261	1
Saudi Arabia	15	— 11.8	12	.....	5	.....	17	— 22.7	122,000	7,176	22	141,490	3
Syria	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	48,000	.....
Trucial Coast	3	— 25.0	2	.....	.....	2	4	+300.0	18,886	9,443	1	10,585	2
Turkey	30	— 23.1	9	.....	27	3	39	+ 14.7	235,142	6,029	34	197,482	3
Miscellaneous	7	+ 40.0	1	.....	4	.....	5	.....	42,577	8,515	.....	.....	1
Asia, Far East	**418**	**— 14.7**	**199**	**174**	**117**	.....	**490**	**+ 26.3**	**2,061,488**	**4,207**	**388**	**1,625,346**	**65**
Afghanistan	4	+ 33.3	2	.....	1	.....	3	+200.0	12,000	4,000	1	*7,000	1
Burma	45	+ 12.5	30	.....	10	.....	40	+ 25.0	155,749	3,894	32	122,700	5
India	75	+ 78.6	28	1	13	.....	42	+100.0	341,000	8,119	21	206,325	14
Japan	275	— 29.0	137	169	81	.....	387	+ 22.1	1,400,185	3,618	317	1,160,773	38
Pakistan	12	+ 9.1	1	2	8	.....	11	+ 22.2	110,000	10,000	9	87,048	3
Taiwan	6	+ 20.0	1	2	2	.....	5	.....	32,554	6,510	5	39,000	4
Thailand	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	*2,500	.....
Miscellaneous	1	— 50.0	.....	.....	2	.....	2	.....	10,000	5,000	.....	.....	.....
Oceania	**155**	**— 36.0**	**147**	**3**	**92**	.....	**242**	**— 0.4**	**620,784**	**2,565**	**243**	**807,954**	**14**
Australia (Incl. Papua)	25	+ 8.7	.....	2	21	.....	23	— 57.4	91,074	3,960	54	121,468	4
Philippines	40	+ 5.3	.....	.....	38	.....	38	+153.3	103,906	2,734	15	72,828	2
North Borneo	15	— 11.8	11	.....	6	.....	17	— 32.0	98,414	5,789	25	150,197	1
New Zealand	2	.....	.....	.....	.....	.....	.....	—100.0	.....	.....	1	13,040	2
Indonesia	70	— 55.1	131	1	24	.....	156	+ 9.9	312,485	2,003	142	420,403	4
Timor (Portuguese)	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	11,355	1
West New Guinea	.....	.....	5	.....	3	.....	8	+100.0	14,905	1,863	4	18,663	.....
Sub-Total	**8,216**	**— 6.5**	**5,206**	**857**	**2,587**	**135**	**8,785**	**+ 11.2**	**47,098,977**	**5,361**	**7,899**	**43,014,005**	**1,021**
United States	**44,102**	**— 5.8**	**22,258**	**5,149**	**18,212**	**1,212**	**46,831**	**— 6.7**	**194,643,317**	**4,156**	**50,179**	**206,199,165**	**3,517**
Total, Free World	**52,318**	**— 5.9**	**27,464**	**6,006**	**20,799**	**1,347**	**55,616**	**— 4.2**	**241,742,294**	**4,347**	**58,078**	**249,213,170**	**4,538**

* Estimate. † Results unknown. ‡ Service wells (water input, gas injections, etc.).

U. S. demand and supply . . .

business recovery promises more consumption of oils

THE PETROLEUM INDUSTRY of the United States has prospects for relatively favorable operating results in the latter half of 1961. This outlook is based primarily on the country's current gradual recovery of business activity, following the mild recession of 1960. Also, the oil industry for more than a year has been rather effectively trying to keep supplies of oils in balance with demand, which has been lagging.

At midyear 1961, however, there was some relapse into imbalance, as domestic production of crude oil and natural gas liquids and imports of crude and products were all failing to stay in line with sluggish demand. Markets for gasoline and some other products threatened to decline again, after having had a sustained recovery between mid-1960 and mid-1961. During that period, with prices better, earnings of oil companies improved materially. But now there is danger that weakening markets may again depress earnings.

As a result of the lagging oil consumption and weak markets of the past few years and oversupplies of

U.S. Crude Oil Production, by States and Districts, in First Half of Year, 1961 and 1960

From U.S. Bureau of Mines, except May and June, 1961, from API weekly reports, and breakdown of Texas by districts from API.

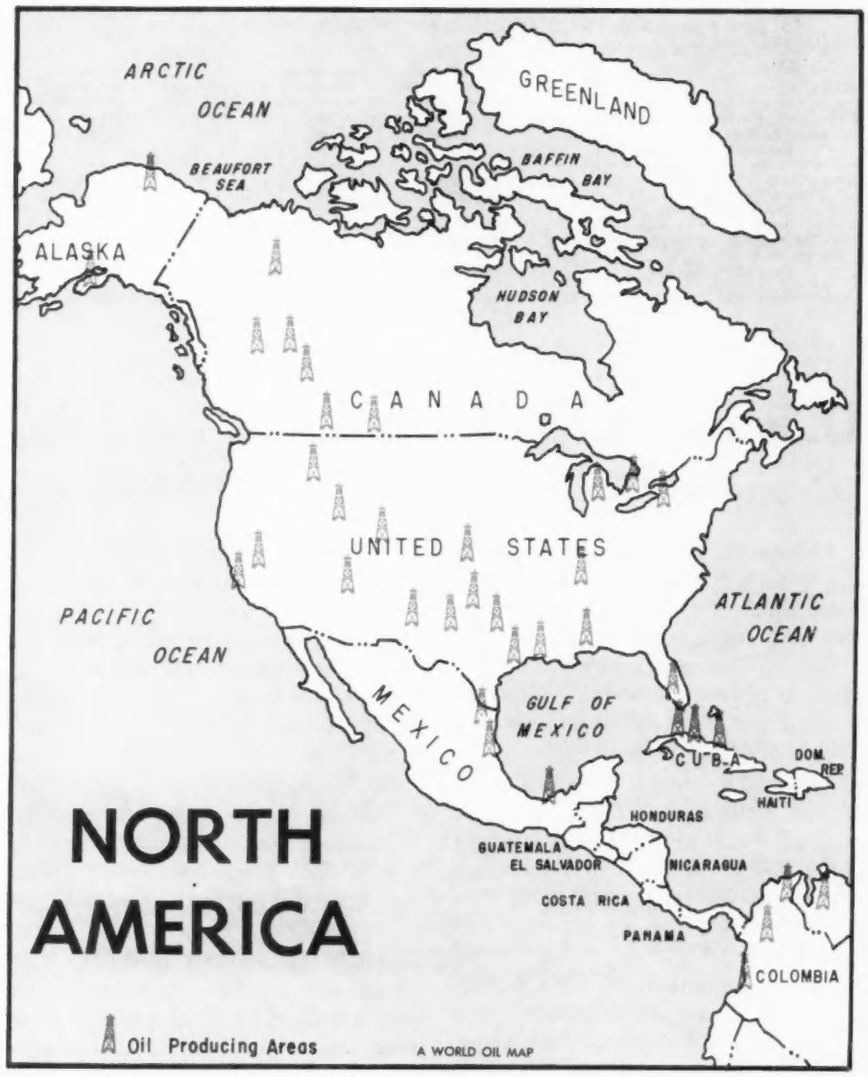
STATE or DISTRICT	Thous. Bbls.		Thous. Bbls. Daily		
	1961	1960	1961	1960	% Diff.
Alabama	**3,604**	**3,380**	**19.9**	**18.6**	**+ 7.0**
Arkansas	**14,949**	**14,232**	**82.6**	**78.2**	**+ 5.6**
California	**149,586**	**151,496**	**826.4**	**832.4**	**— 0.7**
Colorado	**23,656**	**23,292**	**130.7**	**128.0**	**+ 2.1**
Florida	**192**	**195**	**1.1**	**1.1**	.....
Illinois	**38,813**	**39,232**	**214.4**	**215.5**	**— 0.5**
Indiana	**5,586**	**5,737**	**30.9**	**31.5**	**— 1.9**
Kansas	**56,234**	**55,961**	**310.7**	**307.5**	**+ 1.0**
Kentucky	**9,274**	**11,008**	**51.2**	**60.5**	**— 15.4**
Louisiana	**208,608**	**194,389**	**1,152.5**	**1,068.1**	**+ 7.9**
North Louisiana	22,422	22,654	123.9	124.5	— 0.5
South Louisiana	186,186	171,735	1,028.6	943.6	+ 9.0
Michigan	**9,711**	**6,664**	**53.7**	**36.6**	**+ 46.7**
Mississippi	**27,050**	**25,812**	**149.5**	**141.8**	**+ 5.4**
Montana	**15,065**	**14,843**	**83.2**	**81.5**	**+ 2.1**
Nebraska	**12,513**	**11,657**	**69.1**	**64.0**	**+ 8.0**
New Mexico	**55,710**	**53,977**	**307.8**	**296.6**	**+ 3.8**
Southeast N. Mex.	48,138	45,586	266.0	250.5	+ 6.2
Northwest N. Mex.	7,572	8,391	41.8	46.1	— 9.3
New York-Pennsylvania	**3,647**	**4,071**	**20.2**	**22.4**	**— 9.8**
North Dakota	**10,946**	**10,187**	**60.5**	**56.0**	**+ 8.0**
Ohio	**2,352**	**2,503**	**13.0**	**13.7**	**— 5.1**
Oklahoma	**96,787**	**97,714**	**534.7**	**536.9**	**— 0.4**
Texas	**471,835**	**475,951**	**2,606.8**	**2,615.1**	**— 0.3**
Dist. 1: S. Central	8,438	8,035	46.6	44.1	+ 5.7
Dist. 2: Middle Gulf	20,730	21,363	114.5	117.4	— 2.5
Dist. 3: Upper Gulf	63,973	65,956	353.4	362.4	— 2.5
Dist. 4: L. Gulf-S.W.	34,925	34,743	193.0	190.9	+ 1.1
Dist. 5: E. Central	5,022	5,018	27.7	27.6	+ 0.4
Dist. 6: Northeast	46,043	45,752	254.4	251.4	+ 1.2
Dist. 7-B: N. Central	22,990	23,708	127.0	130.3	— 2.5
Dist. 7-C: W. Central	21,436	22,757	118.4	125.0	— 5.3
Dist. 8: West Texas	191,222	188,822	1,056.5	1,037.5	— 1.8
Dist. 9: North Texas	35,234	35,509	194.7	195.1	— 0.2
Dist. 10: Panhandle	19,015	19,778	105.0	108.7	— 3.4
Utah	**17,129**	**19,455**	**94.6**	**106.9**	**— 11.5**
West Virginia	**1,205**	**1,120**	**6.7**	**6.2**	**+ 8.1**
Wyoming	**72,282**	**63,515**	**399.4**	**349.0**	**+ 14.4**
Others†	**2,341**	**301**	**12.9**	**1.6**	**+706.3**
Total, U.S.	**1,309,075**	**1,286,692**	**7,232.5**	**7,069.7**	**+ 2.3**

† Includes Alaska, Missouri, Nevada, South Dakota, Tennessee, and Washington.

oils, the industry has been drilling fewer wells and doing less exploration work. So far, no material recovery of these operations has occurred. But the industry has achieved important economies, and is in a generally sound condition. And it can be expected to proceed henceforth with relatively active operations in the fields and at the refineries.

Total demand for petroleum in 1961 is now estimated by the U.S. Bureau of Mines at 10,036,000 barrels daily, up 157,000 barrels or 1.6 percent over 1960. (See Table.) This includes 188,000 bpd of exports, down 14,000 barrels or 6.9 percent. Domestic demand of 9,848,000 bpd in 1961 would be up 171,000 barrels or 1.8 percent over 1960.

On the basis of this forecast, the bureau estimates that the need for domestic crude oil production in 1961 will average 7,144,000 barrels daily, an increase of 109,000 bpd or 1.5 percent over 1960. Production of natural gas liquids is forecast at 989,000 bpd, up 47,000 barrels or 5 percent. This production will be in balance with needs if crude oil stocks are unchanged, product stocks are reduced slightly, and imports of crude and products do not increase materially over last year's trend. The bureau allowed for total imports of 1,864,000 bpd in 1961, up 45,000 bpd or 2.5 percent.



Supply and Demand for All Oils in the United States,[1] by Quarters, Showing the Year 1960 and a Revised Forecast of 1961

(Thousands Barrels Daily - - - Source: U.S. Bureau of Mines.)

	1st QUARTER			2nd QUARTER			3rd QUARTER			4th QUARTER			YEAR		
	1960	1961[2]	% Up	1960	1961[3]	% Up	1960	1961[3]	% Up	1960	1961[3]	% Up	1960[2]	1961[3]	% Up
SUPPLY															
Production	**8,153**	**8,327**	**2.1**	**7,849**	**8,055**	**2.6**	**7,842**	**8,034**	**2.4**	**8,066**	**8,147**	**1.0**	**7,977**	**8,133**	**2.0**
Crude Oil	7,199	7,326	1.8	6,941	7,110	2.4	6,923	7,060	2.0	7,080	7,117	0.5	7,035	7,144	1.5
Other Oils	954	1,001	4.9	908	945	4.1	919	974	6.0	986	1,030	4.5	942	989	5.0
Imports	**1,953**	**2,081**	**6.6**	**1,824**	**1,779**	**— 1.4**	**1,700**	**1,673**	**— 1.6**	**1,801**	**1,870**	**3.8**	**1,819**	**1,864**	**2.5**
Crude Oil	963	1,064	10.5	1,068	1,013	— 5.1	1,051	1,003	— 4.6	979	1,040	6.2	1,015	1,029	1.4
Products	990	1,017	2.7	756	786	4.0	649	670	3.2	822	830	1.0	804	835	3.9
New Supply	10,106	10,408	3.0	9,673	9,854	1.9	9,542	9,707	1.7	9,867	10,017	1.5	9,796	9,997	2.1
Stock Change	**—695**	**—177**	.....	**+371**	**+319**	.....	**+403**	**+292**	.....	**—412**	**—533**	.....	**—83**	**—39**	.....
Crude Oil	+42	+57	.....	—40	+130	.....	—276	—70	.....	+85	—96	.....	—48	.....	.....
Other Oils[4]	—737	—234	.....	+411	+189	.....	+679	+362	.....	—497	—437	.....	—35	—39	.....
DEMAND															
Total Demand	**10,801**	**10,585**	**— 2.0**	**9,302**	**9,535**	**2.5**	**9,139**	**9,415**	**3.0**	**10,279**	**10,550**	**2.6**	**9,879**	**10,036**	**1.6**
Gasoline	3,778	3,875	2.6	4,421	4,460	0.9	4,415	4,530	2.6	4,116	4,200	2.0	4,183	4,256	1.7
Kerosine	493	500	1.4	228	275	20.6	278	312	12.2	458	499	9.0	364	396	8.8
Distillate	2,738	2,657	— 3.0	1,414	1,550	9.6	1,238	1,290	4.2	2,218	2,260	1.9	1,901	1,929	1.5
Residual	2,014	1,849	— 8.2	1,435	1,435	.....	1,245	1,275	2.4	1,635	1,655	1.2	1,582	1,567	— 0.9
All Other	1,778	1,704	— 4.2	1,804	1,815	0.6	1,963	2,008	2.3	1,852	1,936	4.5	1,849	1,888	2.1
Exports	**202**	**169**	**—16.3**	**230**	**190**	**—17.4**	**193**	**200**	**3.6**	**185**	**190**	**2.7**	**202**	**188**	**— 6.9**
Crude Oil	9	8	—11.1	9	5	—44.4	6	5	—16.7	9	5	—44.4	8	6	—25.0
Products	193	161	—16.6	221	185	—16.3	187	195	4.3	176	185	5.1	194	182	— 6.2
Domestic Demand	**10,599**	**10,416**	**— 1.7**	**9,072**	**9,345**	**3.0**	**8,946**	**9,215**	**3.0**	**10,094**	**10,360**	**2.6**	**9,677**	**9,848**	**1.8**
Gasoline	3,744	3,852	2.9	4,373	4,415	1.0	4,378	4,490	2.6	4,087	4,165	1.9	4,146	4,218	1.7
Kerosine	490	499	1.8	226	273	20.8	276	310	12.3	457	495	8.3	362	394	8.8
Distillate	2,708	2,640	— 2.5	1,380	1,520	10.1	1,214	1,260	3.8	2,199	2,230	1.4	1,874	1,902	1.5
Residual	1,957	1,810	— 7.5	1,378	1,395	1.2	1,200	1,225	2.1	1,591	1,600	0.6	1,531	1,521	— 0.7
All Other	1,700	1,615	— 5.0	1,715	1,742	1.6	1,878	1,930	2.8	1,760	1,870	6.3	1,764	1,813	2.8
Crude Runs to Stills	8,088	8,301	2.6	8,016	7,960	— 0.7	8,220	8,100	— 1.5	7,944	8,218	3.4	8,067	8,140	0.9

[1] Includes Alaska and Hawaii. [2] Actual. [3] Estimate. [4] Refined products and natural gas liquids.

Summary of U.S. Drilling Forecasts

PERIOD	Total New Wells	Producing Wells	Wildcats	Total Footage
Year: 1961, Forecast	44,102	26,007	8,075	185,989,224
1960, Actual	46,831	27,407	9,107	194,643,317
Percent Change	—5.8	—5.1	—11.3	—4.5
Latter Half: 1961, Forecast	22,889	13,342	4,197	96,009,200
1960, Actual	24,125	14,109	4,605	99,388,051
Percent Change	—5.1	—5.4	— 8.9	—3.4
First Half: 1961, Actual	21,213	12,665	3,878	89,980,024
1960, Actual	22,706	13,298	4,502	95,255,266
Percent Change	—6.6	—4.8	—13.9	—5.5

U.S. drilling forecast . . . more activity

in latter half of 1961 than in first half is indicated

INCREASED DRILLING ACTIVITY for the United States is forecast for the second half of 1961 as compared with the first six months. However, this anticipated upturn will not be sufficient to restore the annual volume of drilling operations to the 1960 proportion by about 2,700 new wells.

WORLD OIL forecasts the drilling of 22,889 wells and 96,009,200 feet of hole in the United States during the latter half of 1961. This prediction is based on a midyear survey of oil company drilling plans.

Gains in second half. This second-half drilling rate would amount to an increase of 1,676 wells, or 7.9 percent, over the 21,213 wells completed in the first six months of the year. Paralleling the predicted improvement in the drilling rate, footage forecast for the last six months of 1961 would represent an upturn of 6,029,176 feet, or 6.7 percent, compared with the first half of the year.

This level of drilling activity for the second half of 1961 would result in a total of 44,102 wells being drilled in the United States during the complete year, a decline of 2,729 wells from 1960.

Footage for the entire year of 1961, it is anticipated, will reach a level of 185,989,224 feet, or 8,654,093 feet less than the footage drilled in 1960.

Slightly improving outlook. U.S. crude oil producers generally are marking time, awaiting a general business improvement which may occur in 1962. For the remainder of 1961, recent trends are likely to continue with a slight improvement. According to the Bureau of Mines revised outlook, a gain in oil demand of slightly less than 3 percent is forecast for the latter half of 1961. Demand in the first half of the year decreased almost 2.5 percent from the first half of 1960.

The Bureau's revised estimate of domestic crude oil production for the latter half of this year forecasts an increase of slightly less than 1.5 percent, for an over-all 1961 annual increase from 1960 of 2 percent.

Increase in producing wells. Based on industry trends and reports, as well as a predicted rise in drilling rates during the last six months of 1961, WORLD OIL forecasts the completion of 13,342 new oil, gas and distillate wells during the period. This would equal a gain over the first half of 677 producing completions. During the first six months, 12,665 new oil, gas and distillate wells were completed. Thus, it is expected that the total for 1961 should reach 26,007 new productive wells, or 1,400 fewer than the total for 1960.

Wildcatting rise indicated. Increased drilling in the United States during the second half of 1961 as compared with the first half will include an upturn in the number of wildcat tests.

WORLD OIL forecasts the drilling of 4,197 wildcat tests in the second half of 1961, as compared with 3,878 in the first half. This indicates completion of 8,075 wildcats in all 1961, a decrease of 1,032 tests or 11.3 percent from the 9,107 wildcats drilled in 1960.

Forecast of U.S. Wildcats to Be Drilled in Latter Half of 1961, and in Year 1961

STATE or DISTRICT	1961 First Half	1961 Latter Half	1961 Year	1960 Year Total	% Diff. 1961-1960
Alabama	5	4	9	10	—10.0
Alaska	4	5	9	9	.....
Arizona	6	6	12	22	—45.5
Arkansas	46	34	80	118	—32.2
California	131	168	299	294	+ 1.7
Colorado	140	186	326	332	— 1.8
Illinois	203	218	421	627	—32.9
Indiana	100	119	219	338	—35.2
Kansas	346	356	702	900	—22.0
Kentucky	27	31	58	56	+ 3.6
Louisiana	244	287	531	539	— 1.5
North Louisiana	111	153	264	237	+11.4
South Louisiana	133	134	267	302	—11.6
* Gulf of Mexico	23	20	43	37	+16.2
Michigan	121	186	307	254	+20.9
Mississippi	73	75	148	250	—40.8
Montana	91	91	182	143	+27.3
Nebraska	228	236	464	435	+ 9.2
New Mexico	121	118	239	344	—30.5
Southeast	97	94	191	240	—20.4
Northwest	24	24	48	104	—53.8
North Dakota	27	23	50	71	—29.6
Ohio	24	25	49	53	— 7.6
Oklahoma	204	205	409	446	— 8.3
Pennsylvania	18	17	35	30	+16.7
South Dakota	3	3	6	8	—25.0
Tennessee	19	16	35	57	—38.6
Texas	1,490	1,540	3,030	3,300	— 8.2
Dist. 1: South Central	133	143	276	322	—14.3
Dist. 2: Middle Gulf	129	118	247	236	+ 4.7
Dist. 3: Upper Gulf	147	148	295	296	— 0.3
Dist. 4: Lower Gulf-S.W.	162	165	327	353	— 7.4
Dist. 5: East Central	67	73	140	112	+25.0
Dist. 6: Northeast	70	75	145	189	—23.3
Dist. 7-B: North Central	272	289	561	649	—13.6
Dist. 7-C: West Central	118	128	246	228	+ 7.9
Dist. 8: West	215	223	438	388	+12.9
Dist. 9: North	145	145	290	445	—34.8
Dist. 10: Panhandle	32	33	65	82	—20.7
Utah	48	49	97	81	+19.8
Wyoming	139	179	318	350	— 9.2
† Other States	20	20	40	40	.....
Total United States	3,878	4,197	8,075	9,107	—11.3

* Gulf of Mexico included in South Louisiana figures. † Other states include Florida, Georgia, Idaho, Maryland, Nevada, North Carolina, Oregon, Virginia and Washington.

Forecast of U.S. Wells and Footage to Be Drilled in Latter Half of 1961, and in Year 1961

Includes new wells drilled for oil or gas, salt water disposal wells, and water and gas-input wells. Excludes old wells deepened.

STATE or DISTRICT	NEW WELLS 1961 [1]First Half	NEW WELLS 1961 [2]Latter Half	NEW WELLS 1961 Year	NEW WELLS 1960 Year Total	NEW WELLS % Diff.	FOOTAGE 1961 [1]First Half	FOOTAGE 1961 [2]Latter Half	FOOTAGE 1961 Year	FOOTAGE 1960 Year Total	FOOTAGE % Diff.
Alabama	**29**	**23**	**52**	**52**	.....	**321,237**	**255,300**	**576,537**	**470,425**	**+ 22.6**
Alaska	**21**	**29**	**50**	**24**	**+108.3**	**224,181**	**339,300**	**563,481**	**240,969**	**+133.8**
Arizona	**10**	**10**	**20**	**27**	**— 25.9**	**18,901**	**19,000**	**37,901**	**68,607**	**— 44.8**
Arkansas	**243**	**257**	**500**	**591**	**— 15.4**	**906,711**	**963,750**	**1,870,461**	**2,129,789**	**— 12.2**
California	**813**	**1,087**	**1,900**	**1,691**	**+ 12.4**	**3,618,066**	**4,837,150**	**8,455,216**	**7,145,783**	**+ 18.3**
Colorado	**261**	**349**	**610**	**694**	**— 12.1**	**1,260,146**	**1,692,650**	**2,952,796**	**3,548,526**	**— 16.8**
Illinois	**759**	**823**	**1,582**	**1,922**	**— 17.7**	**1,684,509**	**1,810,600**	**3,495,109**	**4,089,766**	**— 14.6**
Indiana	**357**	**428**	**785**	**1,040**	**— 24.5**	**551,626**	**663,400**	**1,215,026**	**1,405,822**	**— 13.6**
Kansas	**2,289**	**2,361**	**4,650**	**5,039**	**— 7.7**	**8,191,961**	**8,499,600**	**16,691,561**	**17,725,692**	**— 5.8**
Kentucky	**1,068**	**1,242**	**2,310**	**2,931**	**— 21.2**	**794,474**	**931,500**	**1,725,974**	**2,309,276**	**— 25.3**
Louisiana	**1,737**	**2,013**	**3,750**	**3,638**	**+ 3.1**	**13,319,140**	**14,371,050**	**27,690,190**	**27,972,877**	**— 1.0**
North Louisiana	670	930	1,600	1,450	+ 10.3	2,257,158	3,162,000	5,419,158	5,331,593	+ 1.6
South Louisiana	1,067	1,083	2,150	2,188	— 1.7	11,061,982	11,209,050	22,271,032	22,641,284	— 1.6
([3] Gulf of Mexico)	263	237	500	505	— 1.0	2,725,960	2,452,950	5,178,910	5,173,068	+ 0.1
Michigan	**314**	**486**	**800**	**852**	**— 6.1**	**1,038,960**	**1,603,800**	**2,642,760**	**3,109,570**	**— 15.0**
Mississippi	**257**	**266**	**523**	**708**	**— 26.1**	**2,571,564**	**2,660,000**	**5,231,564**	**6,944,981**	**— 24.7**
Missouri	**5**	**6**	**11**	**14**	**— 21.4**	**8,354**	**10,200**	**18,554**	**33,900**	**— 45.3**
Montana	**206**	**208**	**414**	**324**	**+ 27.8**	**1,103,073**	**1,112,800**	**2,215,873**	**1,570,996**	**+ 41.0**
Nebraska	**506**	**524**	**1,030**	**926**	**+ 11.2**	**2,282,684**	**2,358,000**	**4,640,684**	**5,101,070**	**— 9.0**
New Mexico	**821**	**807**	**1,628**	**1,817**	**— 10.4**	**4,234,415**	**4,167,550**	**8,401,965**	**8,997,968**	**— 6.6**
Southeast N. Mex.	506	494	1,000	1,199	— 16.6	2,679,528	2,618,200	5,297,728	6,082,654	— 12.9
Northwest N. Mex.	315	313	628	618	+ 1.6	1,554,887	1,549,350	3,104,237	2,915,314	+ 6.5
New York	**175**	**215**	**390**	**336**	**+ 16.1**	**295,125**	**365,500**	**660,625**	**524,822**	**+ 25.9**
North Dakota	**117**	**100**	**217**	**273**	**— 20.5**	**701,566**	**600,000**	**1,301,566**	**1,715,525**	**— 24.1**
Ohio	**464**	**486**	**950**	**1,045**	**— 9.1**	**1,157,842**	**1,215,000**	**2,372,842**	**2,557,693**	**— 7.2**
Oklahoma	**2,322**	**2,353**	**4,675**	**4,537**	**+ 3.0**	**8,630,516**	**8,706,100**	**17,336,616**	**16,971,324**	**+ 2.2**
Pennsylvania	**271**	**274**	**545**	**861**	**— 36.7**	**736,555**	**739,800**	**1,476,355**	**2,380,996**	**— 38.0**
South Dakota	**3**	**3**	**6**	**18**	**— 66.7**	**14,681**	**14,700**	**29,381**	**127,687**	**— 77.0**
Tennessee	**44**	**36**	**80**	**116**	**— 31.0**	**27,118**	**21,600**	**48,718**	**92,779**	**— 47.5**
Texas	**7,070**	**7,325**	**14,395**	**15,050**	**— 4.4**	**31,995,285**	**33,072,750**	**65,068,035**	**68,206,484**	**— 4.6**
Dist. 1: South Central	402	434	836	1,117	— 25.2	1,129,679	1,215,200	2,344,879	2,891,315	— 18.9
Dist. 2: Middle Gulf	394	366	760	738	+ 3.0	2,675,876	2,488,800	5,164,676	5,007,267	+ 3.1
Dist. 3: Upper Gulf	597	603	1,200	1,116	+ 7.5	4,009,418	4,040,100	8,049,518	9,454,385	— 14.9
Dist. 4: Lower Gulf-S.W.	681	701	1,382	1,055	+ 31.0	3,576,507	3,680,250	7,256,757	5,887,046	+ 23.3
Dist. 5: East Central	124	138	262	211	+ 24.2	763,993	848,700	1,612,693	1,039,729	+ 55.1
Dist. 6: Northeast	452	488	940	879	+ 6.9	2,348,344	2,537,600	4,885,944	4,716,538	+ 3.6
Dist. 7-B: North Central	938	1,006	1,944	2,179	— 10.8	2,832,119	3,018,000	5,850,119	6,520,638	— 10.3
Dist. 7-C: West Central	323	352	675	777	— 13.1	1,449,254	1,584,000	3,033,254	3,206,031	— 5.4
Dist. 8: West	1,362	1,423	2,785	2,994	— 7.0	7,470,836	7,826,500	15,297,336	16,982,771	— 9.9
Dist. 9: North	1,222	1,226	2,448	2,871	— 14.7	3,171,563	3,187,600	6,359,163	7,528,032	— 15.5
Dist. 10: Panhandle	575	588	1,163	1,113	+ 4.5	2,567,696	2,646,000	5,213,696	4,972,732	+ 4.8
Utah	**119**	**121**	**240**	**210**	**+ 14.3**	**709,469**	**719,950**	**1,429,419**	**1,191,454**	**+ 20.0**
West Virginia	**486**	**488**	**974**	**1,016**	**— 4.1**	**1,213,833**	**1,220,000**	**2,433,833**	**2,581,364**	**— 5.7**
Wyoming	**416**	**549**	**965**	**1,038**	**— 7.0**	**2,216,808**	**2,937,150**	**5,153,958**	**5,238,364**	**— 1.6**
[4] Other States	**30**	**20**	**50**	**41**	**+ 21.9**	**151,224**	**101,000**	**252,224**	**188,808**	**+ 33.6**
Total United States	**21,213**	**22,889**	**44,102**	**46,831**	**— 5.8**	**89,980,024**	**96,009,200**	**185,989,224**	**194,643,317**	**— 4.5**

[1] Actual. [2] Forecast. [3] Included in South Louisiana total. [4] Includes Fla., Ga., Idaho, Md., Nev., N.C., Ore., Va., and Wash.

Canada . . . new pipe lines spur gas exploration. Exploration moves north

CANADA'S PETROLEUM INDUSTRY further expanded in 1960, as new pipe lines broadened markets for oil and natural gas. Crude oil production was stepped up by about 18,000 barrels daily or 3.5 percent to 524,158 bpd. Oil wells on production rose to 14,618 at the end of 1960 from 14,002 one year earlier. Slightly more wells and footage were drilled in 1960 than in 1959. Crude reserves were proved up in excess of production, and showed a net increase of 182 million barrels to almost 3.7 billion barrels at the end of 1960 (Tables 1 and 2).

In 1961, however, there has been a decrease in drilling in Canada. The Dominion may have only about 2,500 well completions in 1961, approximately 400 wells or 13.6 percent less than the 2,897 of 1960. Western Canada is expected to complete about 2,282 wells in 1961, a drop of 341 wells or 13 percent. It had a decrease of 12.2 percent in this year's first half (Table 3).

The success ratio of exploratory drilling in Western Canda improved in 1960. But the potential and size of new discoveries generally were below those of previous years. Few significant discoveries were recorded.

As had been expected, natural gas started coming into its own in 1960. With crash pipe line construction programs already in full swing early in 1961, this segment of the industry likely will overshadow oil development for some time to come. Natural gas production, averaging in excess of 2 billion cubic feet per day, showed a gain of 20 percent in 1960.

Use of Western Canadian crude oil in Canadian refineries dropped off slightly in 1960. But this minor decrease was more than offset by increased exports to the United States.

Following are some of the major highlights of oil and gas development in 1960 and 1961 in Western Canada, the Dominion's principal petroleum producing region.

- Cautious optimism was generated by expanding markets for crude oil and gas and by prospects for in-

TABLE 1—Drilling and Production in Canada in 1960 and 1959

ITEM	1960	1959
DRILLING		
Wells Completed	**2,897**	**2,856**
Oil	1,573	1,470
Gas	416	395
Dry	843	991
Service	65	.....
Footage Drilled, thous. ft.	**13,897**	**13,208**
Average Depth	4,797	4,625
Wells Drilling, Yr. End	**208**	**255**
PRODUCTION		
Producing Oil Wells, Yr. End	**14,618**	**14,002**
Flowing	4,790	4,373
Artificial Lift	9,828	9,629
Crude Oil Production, thous. bbls.	**191,842**	**184,768**
Barrels Daily	524,158	506,213
RESERVES		
Crude Oil Reserves, Yr. End, million bbls.	**3.679**	**3.497**

OIL AND GAS FIELDS, PIPE LINES, AND REFINERIES OF CANADA

TABLE 2—Canada's Reserves, Production, Producing Wells, Drilling, and Refining in 1960

ITEM	Alberta	Saskatchewan	Manitoba	British Columbia	[4]Yukon Territory	N.W. Territories	Ontario	Quebec	New Brunswick	Total Canada
[1] **Proved reserves of liquid hydrocarbons at end of 1960, thous. bbls.**	**3,536,258**	**522,551**	**20,750**	**77,938**	.....	**51,498**	**8,068**	.....	.....	**4,217,063**
Crude Oil	3,051,192	502,078	20,750	44,956	.....	51,498	8,068	.....	.....	3,678,542
Natural gas liquids	485,066	20,473	.....	32,982	.....	.....	.....	.....	.....	538,521
* **Gas reserves, end 1960, million cu. ft.**	**26,014,370**	**1,305,759**	**1,559**	**3,097,930**	.....	**37,366**	**177,731**	.....	**39,337**	**30,674,052**
[2]**Crude oil production in 1960, bbls.**	**132,872,071**	**51,867,633**	**4,764,045**	**863,965**	.....	**455,245**	**1,004,710**	.....	**14,146**	**191,841,815**
Barrels daily	363,038	141,715	13,016	2,361	.....	1,244	2,745	.....	39	524,158
[3]**Natural gas production in 1960, mcf.**	**383,682,304**	**33,485,100**	.....	**85,592,166**	.....	**39,785**	**17,122,333**	.....	**98,701**	**520,020,389**
Thousand cubic feet daily	1,048,312	91,489	.....	233,858	.....	109	46,782	.....	270	1,420,821
Crude oil wells, end 1960, producing	**8,633**	**3,685**	**755**	**52**	.....	**35**	**1,432**	.....	**26**	**14,618**
Flowing	3,503	[5]1,200	2	50	.....	35	.....	.....	.....	4,790
Artificial Lift	5,130	[5]2,485	753	2	.....	.....	1,432	.....	26	9,828
Capable of producing	9,878	4,435	893	104	1	49	1,432	.....	26	16,818
Wells completed in 1960	**1,766**	**618**	**63**	**149**	**1**	**26**	**266**	**6**	**2**	**2,897**
Oil	985	444	48	47	.....	.....	49	.....	.....	1,573
Gas	276	10	.....	37	.....	1	92	.....	.....	416
Dry	443	162	14	65	1	25	125	6	2	843
Service	62	2	1	.....	.....	.....	.....	.....	.....	65
Footage drilled in 1960	**10,149,097**	**2,340,131**	**144,095**	**766,598**	**11,447**	**83,851**	**384,226**	**4,528**	**13,023**	**13,896,996**
Wells drilling at end of 1960	**152**	**13**	.....	**24**	.....	**5**	**14**	.....	.....	**208**
Number of refineries in 1960	**11**	**6**	**3**	**6**	.....	**1**	**7**	**6**	**2**	**42**
Daily crude charging capacity, bbls.	98,500	64,200	35,000	97,250	.....	1,300	253,200	291,500	40,300	881,250
Daily average crude runs to stills, bbls.	70,950	50,022	33,000	65,766	.....	1,363	206,700	258,900	....[6]	686,701

[1] **Estimates of proved reserves are from Canadian Petroleum Association.** [2] **Includes field condensate production.** [3] **Does not include waste gas burned in the field.** [4] **No data available on the single oil-gas field in Yukon Territory.** [5] **Estimate.** [6] **Data not available.**

creased activity in the Peace River and Arctic areas.

• The Canadian government's new oil policy promises sharply increased crude production.

• Interest in Arctic exploration quickened during 1960, and by mid-1961, an eight-company group was assembling a rig for shipment to Melville Island, in the Arctic, to drill a 10,000-foot test.

• Alberta's "Cardium Alley" continued to expand. If developments now under way succeed, this Cardium zone trend may become a single field 1½ miles wide by 35 miles long.

• Saskatchewan, although still holding second place next to Alberta in number of completions, experienced a slow-down in drilling during 1960. Many of the proven areas were nearly drilled up.

• British Columbia was starting to feel a pick-up in activity in both crude

and natural gas. A crude pipe line, to provide the first sustained market outlet for most of its shut-in oil fields in the Peace River area, was under construction. Many operators were mapping plans for greatly stepped-up development drilling. Predictions of 200 to 500 new oil wells, to be drilled in the near future, have been made. Gas exploration, spurred by another proposed gas pipe line into northeastern British Columbia, is expected to expand further.

• In the Northwest Territories, a Slave Point gas discovery of major proportions in the Celibeta Lake area was expected to touch off additional exploratory tests in the region.

Arctic exploration picking up. Although southern Canada has been only sparsely tested, exploration frontier is being pushed farther north. A major development in 1960 was the land play that saw operators file on acreage around and beyond the North Magnetic Pole. Much preliminary exploration work has been done, and drilling in the Arctic Islands may occur this year.

The Canadian government's national oil policy, announced February 1, 1961, promises greatly increased production for Western Canada. The 640,000 barrels daily set as the target for 1961 would be a 17.7 percent increase over 1960, and would stimulate the industry. Potential to produce has climbed above 1,150,000 barrels per day, while Canadian consumption of crude in 1960 stood at 855,000 bpd.

Stringent controls threatened. The national oil policy calls for production by the end of 1963 of 800,000 barrels daily, under threat of replacing voluntary measures with more stringent controls.

The past year was a lean period for Western Canada's geophysical drilling contracting and supply divisions. Trimmed budgets and diversion of money from exploration into plant development were among the causes.

The cut-back in geophysical exploration so far has not retarded oil and gas discoveries. But the serious-minded recognize this possibility.

Rig Activity. The approximately 50 drilling contracting firms, and oil companies operating their own rigs, had 255 active rigs in January 1960, some 20 more than in January 1959. Winter drilling reached a peak in March 1960, with 271 out of 318 available rigs active. At mid-year 1960 the rig count had dropped to 179. But this was 14 above the 165 rotaries at work in mid-1959. At year-end 194 rigs were operating.

The year was a period of consolidation, particularly in the drilling contracting business. Few new rigs were brought into Western Canada in 1960, and this trend is expected to continue. Up-dating of equipment to achieve faster penetration rates and greater efficiency was common throughout the industry.

Fewer holes drilled and greater drilling efficiency made drilling contracting even more competitive in 1960. In the supply business the fewer well completions did not hurt nearly as much as the competition from used equipment and the drawdown on inventories, as firms changed purchasing habits.

Most provinces show gains. Completions in Western Canada in 1960 totaled 2,623 wells, and consisted of 1,524 oil, 324 gas, 710 dry, and 65 service wells. All provinces except Saskatchewan, had gains in completions. (Table 2).

Alberta accounted for 67 percent of all wells drilled in Western Canada in 1960.

Saskatchewan slipped in drilling but held second place. Drilling up of many proved productive areas and lack of significant new discoveries retarded activity.

British Columbia, for the third successive year, recorded the third largest number of well completions in Western Canada.

Manitoba in 1960 had 63 completions, including 48 oil wells and 14 abandonments.

Northwest Territories in 1960 had the busiest year since development of the Norman Wells oil field. Of 25 exploratory holes drilled, one resulted in a gas discovery and 24 were dry holes. One dry hole was drilled in Yukon Territory.

British Columbia may have an active oil development drilling program this year if pipe line outlets can be completed.

More discoveries in 1960. Increased exploratory drilling resulted in 48 oil and 69 gas discoveries in Western Canada in 1960. Of the total of 117 discoveries in Western Canada, 15 more than in 1959, 86 were in Alberta, 20 in British Columbia, 10 in Saskatchewan and one in Northwest Territories.

Alberta discoveries included 34 oil and 52 gas; British Columbia 5 oil and 15 gas; Saskatchewan 26 oil and 3 gas; and the single Northwest Territories discovery was a significant gas strike.

Exploration drilling in Western Canda during 1960 generally was disappointing. The success ratio was better than in 1959. But potentials of new discoveries were weaker. The so-called "Cardium Alley," a Cardium zone trend in southwestern Alberta, could be considered the most important oil exploration and development area. The Celibeta Lake gas discovery in Northwest Territories was the most outstanding in the gas category.

Among the more important British Columbia finds were gas discoveries in the Komie Creek, Beaver River and Pocketknife areas.

Alberta recorded a multi-zone producer in the Knappen district; important Mississippian and Crossfield gas on a new trend at Crossfield; and shallow-depth Mississippian gas in the Wildhorse Creek district of the Alberta Foothills.

Cardium trend expands. Alberta's significant Cardium zone trend continued to grow in extent and importance. Starting in late 1959 with Cree Oil Company's 166-barrels per day Cardium zone light gravity discovery at 6,630 feet near Carstairs, the trend since has been expanded by a number of separate discoveries to the northwest and southeast.

TABLE 3—Forecasts of Drilling in Western Canada in 2nd Half of 1961 and Year 1961

Figures for all other periods are actual records.

Period	Wells Drilled				Footage Drilled			
	1959	1960	1961	% Diff.	1959	1960	1961	% Diff.
1st. Half	1,216	1,175	1,032	—12.2	6,125,303	6,454,050	5,911,478	—8.4
2nd. Half	1,353	1,448	1,250	—13.7	6,666,609	7,041,169	7,156,250	—1.6
Year	2,569	2,623	2,282	—13.0	12,791,912	13,495,219	13,067,728	—3.2

CANADA

During 1960 the trend was extended five miles northwest to the Westcott Cardium sand oil producing pool, and 15 miles southeast to a Cardium well in the Crossfield gas field. How much farther the trend extends to the southeast is unknown. Many feel it will connect with a pair of Cardium finds another 15 miles southeast and only four miles north of Calgary's city limits. It would then constitute a field 1½ miles wide by 35 miles long.

Of importance to operators in this trend is the fact that Cremona Pipeline Co.'s crude transmission system runs parallel and not more than three miles distant from the Sundre-Harmattan group of Mississippian oil fields on the north directly to refineries at Calgary.

In Northwest Territories the Home-Signal-Kern County Land-Alminex-United group's first wildcat, Celibeta No. 1, in the Celibeta Lake area, in March, 1960, was abandoned in the pre-Cambrian at 6,267 feet. Their Celibeta No. 2 hole, five miles to the northeast, found the Slave Point member of Middle Devonian at 3,750 feet. The important discovery was tested initially at flow rates of nearly 8,000,000 cubic feet per day. Work has started on two more tests in the same vicinity. The discovery is 30 miles northwest of the Petitot gas discovery, which also found prolific gas in the Slave Point formation.

Multi-zone border discovery. In Alberta, another Home Oil Company Limited wildcat, Home-Pacific-Knappen No. 16-29-1-11, drilled as a deep test in the extreme southeastern part of the province, might prove to be a significant discovery. The well, about 5½ miles north of the Alberta-Montana boundary, when tested down to 2,700 feet, found three separate indicated commercial gas zones. Subsequent tests between 4,500 feet and total depth in the Cambrian at 5,967 feet, have indicated at least another three non-combustible gas bearing zones carrying commercial amounts of helium.

B.C. gas discoveries. Three important natural gas discoveries highlighted activity in northeastern British Columbia in 1960. They were Pan American's Beaver River, Komie Creek discoveries and Pacific Petroleums-Hudson's Bay's Pocketknife discovery. All three appear to be the best uncovered in 1960. The Beaver River test was tested for a flow rate of 3,600,000 cubic feet per day from the Devonian Carbonate at about 11,425 feet. The Komie Creek test blew out of control from the Devonian Slave Point during drilling, but the flow was controlled and the well was cased and suspended. The Pocketknife discovery was in the Mississippian horizon. Located on the Pocketknife anticline—a huge visible 20-mile long structure that extends in a northwest-southeast direction—the well flowed on drill stem test at the rate of 7,448,000 cubic feet daily and at rates almost double that figure during initial flow tests.

The Beaver River discovery is the most northwesterly hole yet drilled in the northeastern sector of British Columbia. It is some 100 miles northwest of Fort Nelson. The Komie Creek strike is 42 miles northeast of Fort Nelson and about 35 miles south-southwest of the Petitot River gas field. Pan American is starting new follow-up drilling at both discoveries.

The Pocketknife discovery is 115 miles northwest of Fort St. John and 20 miles northwest and along the same trend as the earlier Sinclair Pacific Lily d-12-K Mississippian gas find.

TABLE 4—Drilling in Western Canada in First Half of Year, 1961 and 1960, by Provinces

*Province and Year (First Half)	Wells Completed					Footage
	Oil	Gas	Dry	Service	Total	
Alberta						
1961	340	134	196	18	688	4,507,727
1960	453	114	211	4	782	4,825,745
British Columbia						
1961	11	29	35	..	75	404,475
1960	32	19	41	..	92	478,426
Manitoba						
1961	8	...	2	1	11	22,297
1960	21	...	10	..	31	65,464
N.W. Territories						
1961	...	1	12	..	13	58,393
1960	...	1	18	..	19	59,301
Saskatchewan						
1961	189	2	53	1	245	918,586
1960	178	9	64	..	251	1,025,114
Total, W. Canada						
1961	548	166	298	20	1,032	5,911,478
1960	684	143	344	4	1,175	6,454,050

TABLE 5—Rigs Operating in Western Canada at End of 1960, by Provinces, and by Owners

ITEM	End of Year	
	1960	1959
Data by Provinces—		
Alberta	152	185
British Columbia	24	36
Manitoba	...	4
Northwest Territories	5	5
Saskatchewan	13	25
Data by Owners—		
Contractors, Total	190	249
U.S. Contractors	51	70
Canadian Contractors	139	179
Oil Companies	4	6
Total, Western Canada	194	255

Gas pipe lines provide market outlet. Two major pipe lines, each to have a tremendous impact on the economy, are being rushed to completion in Western Canada. The Alberta Gas Trunk Line, a 36-inch gas transmission line extending along the west side of Alberta is a $90 million project. The foothills section is being built. The line will carry gas from western Alberta fields to California. Principal owner of gas that will flow through this line is Alberta & Southern Gas Co., a unit of Pacific Gas & Electric Co. But the line also will feed gas to Westcoast Transmission Company and Montana Power Company distribution systems. The $300 million project is scheduled to be in operation by November, 1961.

The largest gas plant construction program in the history of Alberta is under way at various gas fields along the pipe line route, as producers prepare to clean gas for marketing. At the southern end of the gathering system Shell Oil & Saratoga Processing Co. are building separate gas plants to process production from the Waterton Park and Savanna Creek fields. The Shell project will cost about $20,000,000, and Saratoga's plant and allied facilities will amount to $10 million. Farther north, at Wildcat Hills, Calgary, Carstairs and Windfall, other new construction plus expansion of presently operating plants will boost expenditures above $80,000,000.

Outlet for B.C. crude. In British Columbia a 12-inch crude line, from oil fields in the northeast sector of the province to Kamloops, is under construction. Western Pacific Products Crude Oil Pipelines, a subsidiary of Westcoast Transmission Co., was formed to build and operate the 505-mile, $30 million line. It will give B.C. oil producers in the Peace River sector, with about 12,000 barrels per day potential production, a direct pipe line connection with refineries in the Vancouver area. This should spark an active oil development play in the province's major producing areas, such as Boundary Lake, Milligan Creek and Beatton River. Oil should be flowing to market through this line by October 1961.

B.C. oil drilling program to start. Completion of this line will spur an intensive oil development program in the Peace River area of northeastern British Columbia. Drilling of some 200 new development wells probably will be commenced almost immediately in the seven fields already established. Companies holding productive acreage in that area are mapping drilling programs for possibly 400 to 500 oil wells, which would require moving in perhaps 50 drilling rigs.

Ontario development drilling up. Development well drilling in Ontario in 1960 increased four percent over 1959. Of 81 gas completions, 29 were in Lake Erie. There were 47 oil completions. Production of oil and gas increased slightly over 1959.

Exploratory drilling declined by 19 percent. But of 94 wildcats drilled, 11 were gas finds and two found oil. These discoveries included six new field discoveries, three new pool discoveries, and four outpost finds. Most important of the new finds was the Gobles field in Oxford County, where gas was found initially in the Cambrian and where follow-up drilling found a substantial oil zone.

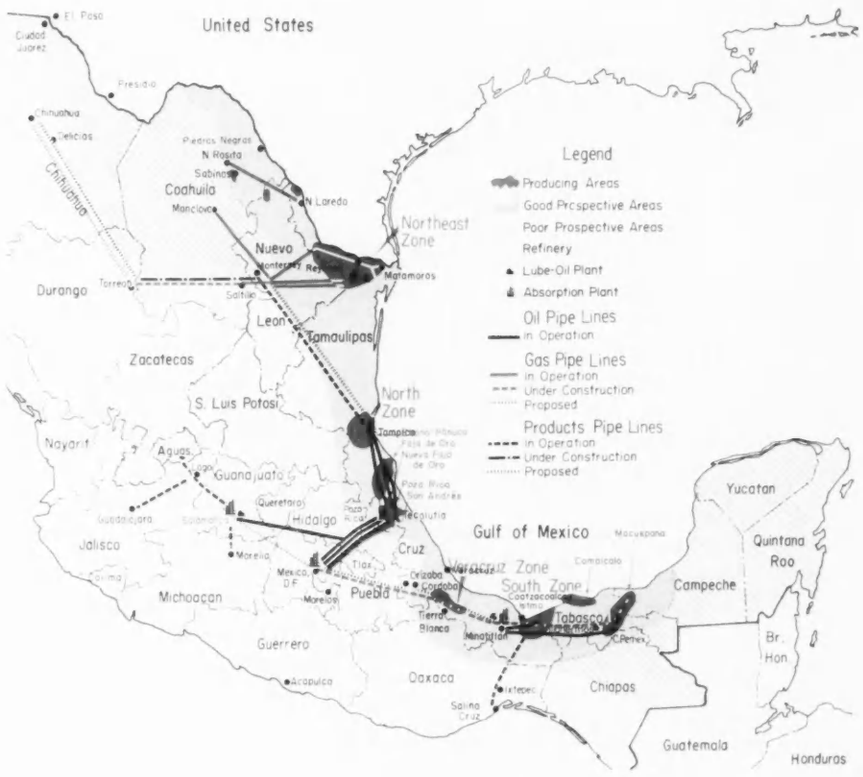
Geophysical activity in Ontario declined about 30 percent from 1959, due mainly to confining of exploratory work to the more developed areas. Land holdings were down 29 percent, with a considerable drop being in the lake acreage.

Quebec exploration increasing. Survey parties increased during 1960, reflecting a shift in emphasis from the St. Lawrence Lowlands to the Gaspe area. More than 10 months of surface and 1½ months of gravity survey work was done on the peninsula.

During 1960 five shallow tests were drilled in the St. Lawrence Lowlands. Four of the tests had small gas shows. The fifth found gas in the drift at 240 feet, but the well cratered and had to be abandoned. A program evaluating this shallow gas play is under way. In the Gaspe area one well was drilled. Oil shows reportedly were found in sandstone and limestone sections.

New Brunswick activity slow. Two wells, one drilled to 5,081 feet near the Stony Creek gas field and the other to 7,942 feet, at Dorchester, were drilled to the Mississippian. But both were dry. Production of both oil and gas decreased.

OIL AND GAS FIELDS, PIPE LINES, AND REFINERIES OF MEXICO



Following temporary curtailment in early 1961, drilling in Mexico is again increasing. It now appears that drilling for 1961 may match the 1960 record.

Mexico . . . New records set in 1960 in drilling, production, and refining. Fourteen new fields found

MEXICO'S PETROLEUM INDUSTRY, operated by the government company, Petroleos Mexicanos (Pemex), closed out its busiest year in December 1960. It set new records in drilling, production, refinery runs, and domestic sales. And one of its most ambitious years of expansion of facilities was recorded.

But suddenly at the beginning of the new year 1961, Pemex entered upon a program of retrenchment. Previous plans for further broad expansion, with emphasis on petrochemicals production, were suspended. New construction was halted. Exploration and drilling were curtailed. Contract drilling was reduced. Many workers lost their jobs with Pemex, drilling contractors, and mills supplying pipe and equipment to Pemex.

It was reported that the retrenchment occurred because Pemex overspent its budget in 1960. Another reason cited was that Mexico had built up a surplus of heavy crude in the fields found and developed, reducing the need for additional heavy crude producing capacity.

Mexico's total exports of heavy crude and residual fuel oil dropped to 20,590 barrels daily in 1960 from 36,615 bpd in 1959. (Table 6.) This reflected especially the stricter U.S. controls on imports.

But domestic sales of petroleum products increased. They averaged 235,277 barrels daily in 1960, up 17,493 bpd or 8 percent over 1959. (Table 5.) Thus total sales, domestic and export, were up slightly.

MEXICO

Production. Crude oil production in 1960 averaged 270,582 barrels daily, an increase of 6,492 bpd or 2.5 percent over 1959. (Table 2.) Production of natural gas liquids averaged 26,564 bpd, up slightly. Production of natural gas averaged 932 million cubic feet daily, an increase of 3.4 percent. All these production figures for 1960 set new records.

Increases were achieved in 1960 in reserves of natural gas and natural gas liquids. Reserves of crude oil were maintained undiminished while 99 million barrels of crude were being produced, as new reserves were proved up in the same volume as current production. (Table 3.)

Refinery runs to stills averaged 293,113 barrels daily in 1960, an increase of 5,639 bpd or 2.0 percent, and also a new record. (Table 4.)

Drilling. Both wells and footage drilled in Mexico set new records far above any recent previous year. The 1960 drilling was sharply above that of 1959 and double that of 1958 or the several preceding years. (Table 1.) In 1960, there were 762 wells completed, an increase of 322 wells or 73.2 percent over the 440 completions of 1959, and comparing with 379 wells drilled in 1958.

Footage drilled was increased proportionately to 5,266,573 feet in 1960, an all time record, from 3,102,410 feet in 1959 and 2,636,740 feet in 1958. Wells completed in 1960 averaged 6,912 feet per well in depth, compared with 7,051 feet in 1959 and 6,957 feet in 1958.

Drilling rigs in operation increased from 96 at the end of 1959 to 133 on May 31, 1960, and about 145 at the close of 1960. Pemex was reported to have laid off some private contractors early in 1961. But by mid-year 1961, drilling was picking up again.

The rig count at mid-year 1961 was 144 and rising. It was then indicated that drilling for 1961 might match the 1960 record.

TABLE 1—Wells Drilled in Mexico, by Years

YEAR	Wildcats	Development	Total Wells	Productive	Dry	FOOTAGE Feet	FOOTAGE Avg. Depth	Drilling Yr. End
1956	93	309	402	266	136	2,173,786	5,407	....
1957	108	281	389	273	116	2,514,778	6,465	68
1958	76	303	379	286	93	2,636,740	6,957	75
1959	81	359	440	298	142	3,102,410	7,051	96
1960	103	659	762	578	184	5,266,573	6,912	145*

* Unofficial estimate.

TABLE 2—Production of Crude Oil, Natural Gas Liquids, and Natural Gas in Mexico, by Years*

YEAR	Crude Oil* Total Barrels	Crude Oil* Bbls. Daily	Natural Gas Liquids Total Barrels	Natural Gas Liquids Bbls. Daily	Total Oils Total Barrels	Total Oils Bbls. Daily	Natural Gas, Million Cu. Ft. Year	Natural Gas, Million Cu. Ft. Daily
1956	90,659,739	247,704	3,436,616	9,390	94,096,355	257,094	124,795	341
1957	88,265,979	241,825	3,931,318	10,770	92,197,297	252,595	161,331	442
1958	93,533,445	256,256	7,107,959	19,474	100,641,404	275,730	262,661	720
1959	96,393,040	264,090	9,365,431	25,659	105,758,471	289,750	328,836	901
1960	99,032,974	270,582	9,722,314	26,564	108,755,288	297,146	341,265	932

TABLE 3—Estimated Proved Reserves in Mexico at End of Year

ITEM	1960	1959
Liquid hydrocarbons, million bbls.	2,763	2,723
Crude oil	2,458	2,458
Natural gas liquids	305	265
Natural gas, billion cu. ft	....	8,059
Natural gas, million bbls., equivalent*	2,024	1,612
Total oil and gas, in bbls.	4,787	4,335

* Calorific equivalent to crude oil at the rate of 5,000 cubic feet = 1 barrel.

TABLE 4—Crude Oil Runs to Stills at Refineries in Mexico, by Years

YEAR	Total Barrels	Bbls. Daily
1956	82,060,563	224,209
1957	86,369,157	236,628
1958	95,310,699	261,125
1959	104,928,181	287,474
1960	107,279,435	293,113

TABLE 5—Domestic Sales of Petroleum Products in Mexico, by Years

YEAR	Total Barrels	Bbls. Daily
1956	69,784,276	190,667
1957	75,397,269	206,568
1958	78,748,293	215,749
1959	79,491,337	217,784
1960	86,111,446	235,277

TABLE 6—Mexico's Exports and Imports of Petroleum, by Years

YEAR	Exports Total Barrels	Exports Bbls. Daily	Imports Total Barrels	Imports Bbls. Daily	Excess of Exports Over Imports Total Barrels	Excess of Exports Over Imports Bbls. Daily
1956	23,722,020	64,814	11,042,864	30,172	12,679,156	34,642
1957	15,025,970	43,907	10,267,549	28,130	4,758,421	15,777
1958	11,641,427	31,894	6,613,213	18,118	5,028,214	13,776
1959	13,364,383	36,615	2,113,910	5,792	11,250,473	30,823
1960, Total	7,535,965	20,590	1,243,302	3,397	6,292,663	17,193
Crude Oil (Panuco)	1,100,362	3,006	.....	.....	.....	.....
Fuel Oil	6,435,603	17,584	.....	.....	.....	.....

TABLE 7—Production, Producing Wells, and Drilling in Mexico in 1960*

DISTRICT	Production* Crude Oil* Total Bbls.	Crude Oil* Bbls. Daily	Natural Gas Liquids Total Bbls.	Natural Gas Liquids Bbls. Daily	Natural Gas MM Cu. Ft. Total	Natural Gas MM Cu. Ft. Daily	Producing Wells, Year End: Producing Oil Flowing	Pumping	Gas Lift	Total	Producing Gas	Service	Wells Completed: Development	Wildcats: Oil	Gas	Dry	Total	Total Wells
North Zone	**18,320,166**	**50,055**	**2,166,804**	**5,920**	**137,407**	**375.4**	**710**	**75**	**24**	**809**	**233**	**8**	**213**	**1**	**4**	**53**	**58**	**271**
Northeast District	1,039,693	2,841	2,159,269	5,900	121,014	330.6	37	.....	18	55	155	8	37	.....	4	25	.....	.....
N. Dist. (Panuco)	11,074,457	30,258	.....	.....	12,369	33.8	395	72	6	473	75	.....	125	.....	.....	.....	.....	.....
South (Gold Lane)	6,206,016	16,956	7,535	20	4,024	11.1	278	3	.....	281	3	.....	51	1	.....	28	.....	.....
Central Zone	**56,091,106**	**153,254**	**2,543,984**	**6,951**	**74,650**	**203.9**	**398**	**26**	**214**	**638**	.....	**38**	**146**	**3**	.....	**17**	**20**	**166**
Poza Rica District	45,222,257	123,558	2,543,984	6,951	69,191	189.0	271	24	214	509	.....	38	146	3	.....	.....	.....	.....
Nueva Faja de Oro	9,908,234	27,071	.....	.....	5,265	14.4	117	.....	.....	117	.....	.....		.....	.....	.....	.....	.....
Vera Cruz District	960,615	2,625	.....	.....	194	0.5	10	2	.....	12	.....	.....		.....	.....	.....	.....	.....
South Zone	**24,621,702**	**67,273**	**5,011,526**	**13,693**	**129,208**	**353.0**	**305**	**325**	**77**	**707**	**37**	**15**	**300**	**4**	**2**	**19**	**25**	**325**
Isthmus	7,300,067	19,946	98,495	269	5,427	14.8	65	325	48	438	.....	.....	43	1	1	.....	.....	.....
Tabasco District	17,321,635	47,327	4,913,031	13,424	123,781	338.2	240	.....	29	269	37	15	257	3	1	.....	.....	.....
Total Mexico	**99,032,974**	**270,582**	**9,722,314**	**26,564**	**341,265**	**932.3**	**1,413**	**426**	**315**	**2,154**	**270**	**61**	**659**	**8**	**6**	**89**	**103**	**762**
Total, 1959	96,393,044	264,090	9,365,432	25,659	328,792	900.8	1,481	490	323	2,294	211	59	359	9	2	70	81	440

* Crude oil production figures for 1960 in this table differ slightly from those in World Production table, Page 73, being later and slightly revised Pemex data.

Pemex itself owned 96 rigs at the beginning of 1960, but by mid-year 1960 had added 48 new rigs, for a total of 144 Pemex rigs. Contract drilling was encouraged by Pemex in 1960, and the number of contractor rigs in the country increased. Private contractors were operating 37 rigs out of the 133 total on May 31, 1960, while Pemex was using 96. In March 1961 there were 65 contract rigs in Mexico, of which 17 were then shut down.

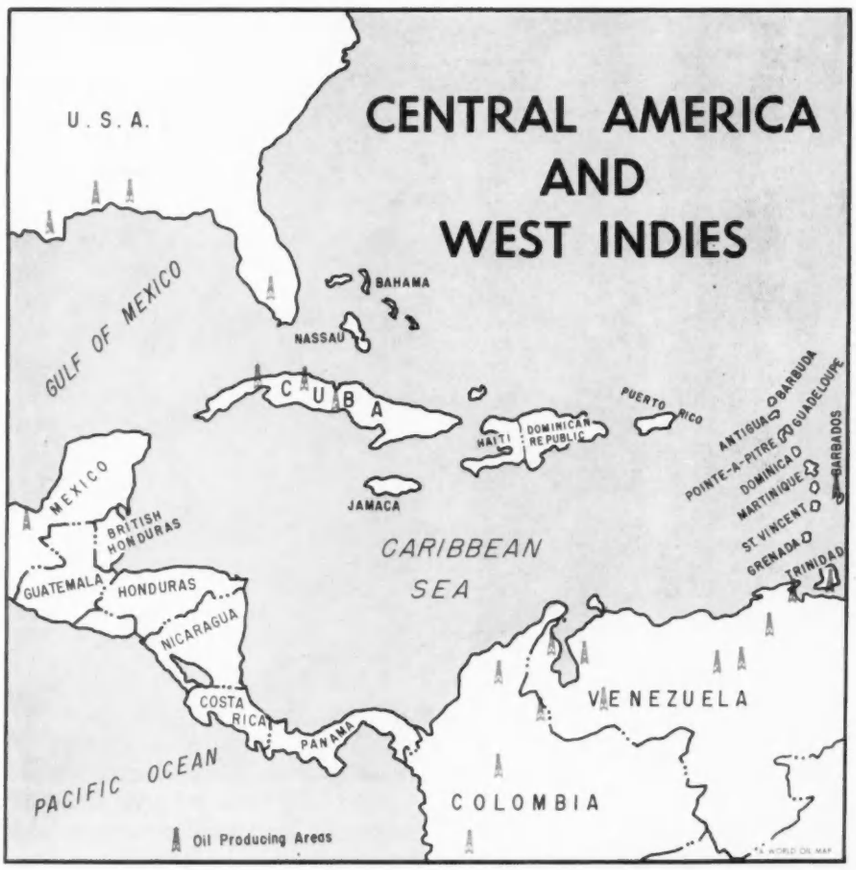
Exploration continued in 1960 in regions of proven and possible production, particularly the Gulf of Mexico coastal plain. Exploration in areas not yet productive included work in Lower California, Chihuahua, Coahuila, and Quintana Roo.

Wildcats completed in 1960 totaled 103, an increase of 22 wells or 27.2 percent over 81 in 1959. They resulted in discovery of 14 new fields. They were Comitas, Ceniza, Benavides, and Palito Blanco in the northeast region; Rancho Nuevo in the south district of the north region; Cabellal, Pital y Mozutla, and San Miguel del Rincon in the Poza Rica district; and Samaria, Tamulte, Yucateco, La Central, Xoteapa, and Cerro Nanchital in the south region. The northeastern fields and Tamulte in the south region are gas-productive, and the remainder are oil fields.

Geological and geophysical work totaling 502 party months was done by an average of 44 exploration groups in operation, including 10 doing surface geological work, 12 studying subsurface geology, 17 seismic crews, and 5 gravity parties.

Development wells drilled in 1960 totaled 659, an increase of 300 wells or 83.6 percent over 359 completed in 1959, and more than twice the 303 drilled in 1958.

Offshore oil in Mexico has been highlighted recently by Continental Oil Co.'s acquisition of a one-half interest in the venture held by Pauley Petroleum, Inc., to develop Santa Ana field in the Bay of Campeche, Tabasco district. In early spring 1961 the field had eight wells producing more than 5,300 bpd from the Miocene at about 10,000 feet. It is on a partially developed and highly faulted salt dome. Four wells had been completed from a potential 12-well platform, from which drilling was to be continued.



CENTRAL AMERICA

British Honduras . . . offshore rig moved in by Phillips Petroleum Company

PHILLIPS PETROLEUM CO. spudded a British Honduras offshore wildcat on February 21, 1961, about three miles off the Caribbean coast, and 75 miles south of Belize, in 22 feet of water depth. The well was being drilled below 2,000 feet on April 1. The company acquired 1,970,000 net acres of leases and licenses in southern British Honduras in 1958, including a high proportion of marine areas. Two onshore dry holes were completed in 1959.

Phillips' 1960 exploration activity consisted of 12 party months of onshore and 5 crew months of offshore seismic work, and 28 party months of surface geology. An onshore seismic crew finished up in March 1961, but two geological parties were to continue active all this year.

Sinclair-BP's joint venture in northern British Honduras has ended. The 1,000 square miles in licenses were surrendered following geological work which indicated poor prospects.

Costa Rica . . . wildcatting is suspended

THREE DRY wildcats were completed in Costa Rica in 1960 by Union Oil Co. of California (operator), jointly with Gulf Oil Corp. Limon 1, at Puerto Limon, was abandoned at 10,181 feet early last year. El Tigre 1, located 10 miles west of Puerto Viejo, was abandoned in June 1960 at 9,223 feet. Telire 1, the next test, was plugged at 8,020 feet at the end of December. Evaluation of geological and geophysical data continued.

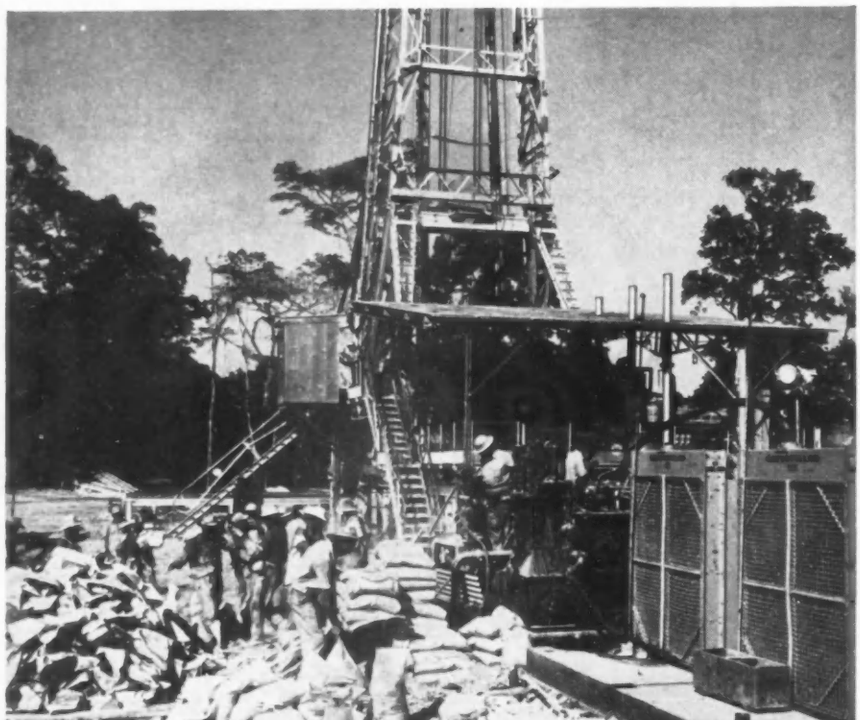


Photo courtesy The Ohio Oil Company

Ohio Oil Company of Guatemala's rotary drilling rig is set high on an anticline in the jungle interior of Guatemala at first exploratory test site.

Panama . . . Delhi drills test near border

DELHI-TAYLOR OIL CORP., through its affiliate, Panamanian Delhi Petrolera Inc., moved a rig into Darien Province, Panama, near the Colombian border late last year; and spudded an 8,000-foot test on January 17, 1961, on a 1,561,000-acre concession. The well reached 6,200 feet later this year. It is located in a Tertiary sedimentary basin. This was the first drilling in Panama since Champlin Oil and Refining Co. finished two dry holes in 1959.

Tradewinds Exploration of Panama S.A. completed photogeologic work on its holdings on the Pacific Coast near Colombia in December 1959, and dropped some acreage on the basis of the survey.

A new petroleum code was reported under consideration. If adopted, it might stimulate more drilling.

Two refineries were planned in Panama. Both were to go on stream in 1962. Each is to have a capacity of 55,000 bpd. They are Panama Refining and Petrochemical's Portobelo refinery (planned), and Refineria Panama SA's Las Minas Bay, Colon plant (under construction) at the Atlantic entrance to the Panama Canal.

Honduras . . . new oil law is considered

ALTHOUGH there was no exploratory activity in Honduras in 1960, an equitable new oil law was reported to be under consideration early in 1961, and enactment of it was anticipated. Renewed exploration was expected to follow this event if it occurred.

Petroleos Hondurenos S.A. has an 11-million-acre concession covering parts of the Interior and Mosquitia basins. An encouraging Mesozoic section has been outlined.

Guatemala . . . acreage being evaluated

SOME WILDCATTING took place in Guatemala in 1960, and some oil shows were encountered. New drilling was scheduled for 1961. A number of operators dropped out of the Guatemala oil play, and considerable acreage in sedimentary areas was open at the end of 1960.

The Ohio Oil Co. of Guatemala abandoned its Chinaja 1 wildcat in Alta Verapaz in March 1960 at 10,806 feet, after finding a show of oil below 10,000 feet. Ohio's second test, San Roman 1, located about 23 miles north-northwest of Chinaja 1, was abandoned after high-pressure salt water was encountered at 10,499 feet. Two minor oil shows were found. Ohio was preparing to drill another rank wildcat, La Pita 1, in the northwestern part of Peten Province at 17° 9′ north latitude, 90° 59′ 45″ west longitude, 80 miles northwest of San Roman 1, near the Mexican border. Pita 1 was to be drilled to about 12,000 feet.

Guatemalan Atlantic Corp. deepened the San Francisco 1A test in Peten to 6,397 feet, abandoned it and ceased operations.

In 1961, Signal Oil and Gas Co. drilled and abandoned a 3,664-foot test on the Canchacan anticline in Peten. The well bottomed in Macal (Permian) shale in March, with no commercial shows reported. Results were being evaluated. No further drilling was contemplated by Signal in the immediate future.

As evaluation of acreage approached a drill-or-forfeit stage, the following other changes were made:

- Tidewater Oil Co. dropped its Guatemalan holdings.
- Delhi Guatemala Exploration Corp. acquired from Texaco, Inc., a 45 percent interest (later increased to 55 percent) in two concessions totaling 1,337,000 acres in northwestern Peten. Delhi did six party months of seismic work last year, and expected to continue shooting in 1961.
- Several other less active operators relinquished their holdings.

Bahamas . . . Sun renews exploration license; activity at a standstill

BAHAMA GULF OIL COMPANY and Bahama California Oil Company suspended operations on their holdings since completion of Cay Sal 1, a deep test abandoned at 18,906 feet in 1959. Sun Production Company of Bahamas Ltd., renewed its exploration license early in 1961 on Great Inagua Island and the submerged area extending to one league from the high water mark. No active exploration was reported as of the spring of 1961.

BAHAMA CALIFORNIA OIL CO., LTD., subsidiary of Standard Oil Co. of California, has renewed its exploration license in 2,865,011 acres in the Turks and Caicos Islands and offshore bank areas for an additional year. Geophysical interpretation and review work were conducted during 1960.

Cuba . . . government takes over; production and drilling at lower levels

THE PETROLEUM INDUSTRY in Cuba came under the full domination of the Castro government during 1960, and development subsequently has been in the hands of the Instituto Cubano del Petróleo (Cuban Petroleum Institute).

Under the Organic Law of the ICP, all branches of the oil industry in Cuba have been integrated under that agency. ICP was empowered to enforce the oil laws of May 9, 1938, and November 20, 1959, previously under the department of mines and petroleum of the ministry of agriculture. ICP also was authorized to administer all intervened companies concerned with oil.

The Texaco, Shell, and Esso (Standard, New Jersey) companies, owners of three refineries in Cuba, refused the government's request of May 17, 1960, to process Russian crude. On June 30, 1960, the three companies were intervened. ICP took over the refineries and began processing Russian crude. It marketed products through its marketing system, using filling stations that previously handled Texaco, Sinclair, and Esso gasoline.

Further confiscations of oil companies were included in Law Decree 851 of October 25, 1960, as part of the nationalization of 164 U.S. companies, in reprisal for the U.S. embargo on products sold to Cuba. Companies affected included Consolidated Development Co. and its subsidiary, Petroleos Cruz Verde, which had equipment and production in Bacuranao worth $200,000; Kewanee Inter-americana, owner of a large rig and equipment worth $1 million; Atlantic Refining Co. which had $50,000 worth of casing left from its operations; Halliburton Oilwell Cementing Co., with $100,000 worth of equipment; Jones Bros. Drilling Co., owner of a medium size rig and equipment worth $300,000; and Cuban Gulf Oil Corp., reported already liquidated and without remaining assets in Cuba.

By the fall of 1960 virtually all private oil concessions had been canceled under the new revolutionary laws, and no new private concessions were to be granted.

All private oil exploration activity had come to an abrupt halt after enactment of the new oil law of November 20, 1959. ICP then was the only organization engaged in exploration work.

Drilling. Late in 1960 ICP had 12 drilling rigs at its disposal. They included one large rig and four small rigs that had been owned by the former government. Also included were one deep rig, five medium rigs, and one shallow rig owned by U.S. contractors before confiscation by the Castro government. ICP was unable to carry out its original plan of operating all available rigs simultaneously. Of the 12 rigs in its hands, two were being operated in 1960 and four in early 1961. The others were being pirated for parts. Replacement parts from the United States could not be obtained.

ICP on July 11, 1960, spudded Barreras 1 in the Santa Maria del Mar-Bacuranao area, 12 miles east of Havana, where small production had been found. It was abandoned as a dry hole at 3,552 feet on August 17, 1960. Barreras 2 was drilled by cable tools to 330 feet but caved in and was abandoned. Barreras 3 in December 1960 was reported to have reached a depth between 3,000 and 3,500 feet. A few shows of oil were encountered, but the test was believed to be dry.

ICP's Madruga 1, four miles west of the town of Madruga, began drilling in October 1960. It was projected to a depth of 10,000 to 12,000 feet, "to study sediments of Cretaceous age." Slight shows of gas were reported above 6,400 feet. In March 1961 it was temporarily suspended at 9,184 feet in Upper Cretaceous limestone, as ICP sought to import needed draw works cable to continue drilling. At the same time Madruga 2, located two miles south of the town of Madruga, was drilling below 3,620 feet. It had a gas show of about 50 pounds pressure. It was projected to 10,000 feet, and a large rig was substituted for a smaller rig at the 3,500 foot level.

In late 1960, ICP spudded Cristales 1 at a site about 22 miles west of the town of Jatibonico, Camaguey province, where several dry holes were

TABLE 1—Summary of Drilling and Production in Cuba

ITEM	1960	1959
Wells Completed	3	13
Oil Wells	.....	3
Dry Holes	3	10
Footage Drilled (Feet)	7,382	26,000
Wells Drilling, Year End	2	1
Crude Oil Production, Bbls.	161,040	194,847
Barrels Daily Average	440	534
Wells Producing, Year End	110	210
Flowing Wells	.....	.....
Pumping Wells	110	210

TABLE 2—Crude Oil Production in Cuba in 1960 and 1959, by Fields and Months

(Barrels Daily)

Field	Province	Year 1959	1960						
			Jan.	Feb.	Mar.	Apr.	May	June	6 Mo. Av.
Jatibonico	Camaguey	373	428	385	445	200	153	148	293
Jarahueca	Las Villas	27	33	14	28	29	28	30	27
Motembo	Las Villas	8	8	7	7	7	6	6	7
Cruz Verde-Bacuranao	Havana	60	35	34	31	28	28	26	30
Santa Maria del Mar	Havana	25	17	18	13	10	14	15	15
Guanabo	Havana	41	19	20	20	14	20	17	18
Total, Cuba	.....	534	540	478	544	288	249	242	390

drilled by Cuban American Oil Co. and Trans-Cuban Oil Co. In March 1961, Cristales 1 was reported to have reached a total depth of 7,544 feet, with the bottom of the hole in Cristales limestone formation. It was further reported to have been evaluated by IPC as a gas producer from a zone at 2,616 feet.

ICP's San Lorenzo 1 was located close to the town of Bejucal, 15½ miles south of Havana, on the Bejucal structure. In March 1961 it was drilling at 3,280 feet, and had found gas shows from 1,640 feet down.

A well was due to be spudded in March 1961 in the Santa Maria del Mar field. At the same time, plans called for three other wells to be started. One was scheduled at Los Palacios, Pinar del Rio province, where Atlantic drilled three dry holes. Another projected test was a second well in the Cristales "gas field." The other well planned was Guayos 2, Las Villas province, near Cuban American's Guayos 1.

Some offshore drilling is contemplated, but will not be undertaken until 1962. One test is planned on the north shelf and another on the shelf of Camaguey province. They would be drilled with Soviet turbo-drill equipment. It was reported that two Soviet rigs capable of drilling to 15,000 feet would be brought in.

In the Cayos area on the north coast of Camaguey province it was planned to drill on structures found by seismic work by the major oil companies. This semi-marine operation would be carried out on the advice of Russian geologists. They estimated that the structures should contain several million barrels of reserves each.

Among several deep tests drilled in the region by the major companies was Shell's Cayo Coco 2, total depth 10,563 feet, which found excellent oil staining and carbonaceous matter in porous Lower Cretaceous dolmite at 8,200 feet under anhydrite caps. Gulf-Kewanee's Collazo 1, at Punta Alegre, depth 13,030 feet, reportedly found over 1,000 feet of salt. Cuban Kewanee's Tina 1, depth 10,500 feet, and other wells drilled into a salt structure at Loma Cunagua. Shell's Manuel 1, drilled to 8,897 feet, cut a major thrust fault at 8,500 feet. Those wells cost over $1 million each.

Exploration. In the spring of 1961 three geological field parties were reported working in northern Las Villas province and two in central Camaguey province.

No geophysical activity was in progress at that time. ICP was waiting for the Russian equipment it expected to receive. Plans called for seismic, gravimetric, and magnetometric work.

Guillermo Salas, Mexican geologist, was the technical advisor and consultant for ICP beginning in November 1959. He made statements in the spring of 1961 about the "good petroleum possibilities of Cuba." Alfonso Gutierrez, Mexican, was Director of the ICP. He predicted the discovery of "profitable oil deposits" in Cuba within the next "few years." Dr. DiGregorio, an Argentine geologist, in late 1960 was made director of ICP's geological department.

Production. At the close of 1960 Cuba's crude oil production was estimated at approximately 500 barrels per day from about 110 producing wells. For the year 1960 the production is reported to have averaged approximately 440 barrels daily, or to have totaled about 161,040 barrels. That would be a decrease of 17.6 percent from the 534 bpd or 194,847 barrels total of 1959, which came from 210 wells, all pumping.

Crude production in Cuba in the first half of 1960 is shown in Table 2. Output is shown by fields and by months. Jatibonico in Camaguey province remained the most important field.

Puerto Rico . . . drilling stopped in 1961

KEWANEE INTERNATIONAL OIL COMPANY had suspended drilling operations in Puerto Rico in the spring of 1961. The Commonwealth of Puerto Rico (CPR) 1 test near Guayanilla on the south coast, drilled in partnership with David L. Gordon, president of Maritime Oil Co. of Houston, and reported below 6,000 feet at the end of 1959, was deepened in 1960 before being abandoned at total depth of 7,480 feet. Following completion of this well the Maritime Oil Co. interests withdrew from the venture.

Kewanee drilled two more dry tests on the south coast, CPR 2 to 4,919 feet and CPR 3 to 4,152 feet. The rig was then moved to the north coast concession granted several years ago in the name of A. D. Fraser of Kingston, Jamaica. CPR 4 was drilled to 6,427 feet at a location five miles east of Arecibo. This test was abandoned by the end of 1960 and the rig was stacked.

Dominican Republic . . . wildcatting program continuing at mid-1961

COMPANIA PETROLERA DOMINICANA, representing both U.S. and Dominican Republic capital, conducted an active wildcatting program in the Dominican Republic during 1960 and through mid-1961 with one rig. Two wells, Km 19-2 and Maleno 1-DT (Table 1), were completed in the Azua vicinity on the south coast last year. Three others were completed in the Enriquillo Valley in 1961. The firm had chosen an additional location, Neiba 1, on the north edge of the central part of the Enriquillo Valley (continuous with Haiti's Cul de Sac Basin[1]) before suspending operations a short time ago.

Km 19-2 bottomed at 10,005 feet

TABLE 1—Wells Completed in Dominican Republic in 1960 and First Half of 1961

(All by Compania Petrolera Dominicana, C por A)

Well, Number, and Location	Date Spudded	Date Abandoned	Total Depth, Feet
Km. 19-2, 5 mi w of abnd. Maleno field	11-12-59	3-10-60	10,005
Maleno 1-DT, 7 mi w-nw of Azua	3-28-60	10-24-60	9,920
Palo Alto 1, 3 mi s 75° e of Palo Alto	11- 5-60	2-15-61	6,568
Mella 2, 1.6 mi ne of old Seaboard-Jersey Standard Mella 1	2-21-61	4-18-61	10,910
Cabritos 1, near Haiti border and Lake Enriquillo, w end of Enriquillo Valley	4-22-61	Mid-1961	6,413

in a thick limestone section of the Sombrerito formation (Oligocene). No shows were encountered. In Maleno 1-DT, however, gas was found in a reef limestone at the top of the Sombrerito in the interval 4,091-4,160 feet, and 4,220 feet of 5½-inch casing was run. The well was suspended without the intended perforating and acidizing being done.

Palo Alto 1 was located near the town of Barahona on a seismic structure. The well ran high but found only hard dense cherty limestone below 1,600 feet with no shows. Mella 2 was abandoned in Miocene salt found below 10,000 feet. Cabritos 1 bottomed in limestone, probably of Oligocene or Eocene age. Traces of asphaltic material but no reservoir rocks were found.

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Trinidad . . . economic difficulties hamper oil development; but crude output and refinery runs rise

PETROLEUM DEVELOPMENT in Trinidad in 1960 was steady, although hampered by weak markets, strikes, increases in costs and other difficulties.

The position of Trinidad oil remained insecure. This situation reflected the fact that conditions for the petroleum industry in a large part of the world continued uncertain, with potential supplies of oils materially exceeding current demand.

Crude oil production and refinery runs in Trinidad were increased in 1960, and more wells were completed than in 1959, although their average depth was shallower and somewhat less footage was drilled.

One company producing oil in Trinidad stated that in terms of cost, its crude was made even less competitive by reason of the result of wage negotiations with the Oilfield Workers Trade Union during 1960. This led to an addition to the company's labor cost of approximately 25%, it said. And in an effort to minimize this large increase in costs, it decided in September to reduce drilling activity from 7 rigs to 5. These statements were made by Trinidad Petroleum Development Co. Ltd., third largest producer in Trinidad, in its annual report, which was issued in early May 1961.

The cost-price squeeze is being dealt with by operating companies through various economies and savings, including reorganizations of operations, curtailment of exploratory drilling, putting emphasis on development drilling and slowing down of expensive off-shore exploration and development.

The above mentioned company, Trinidad Petroleum Development Co., after pointing out increases in its costs, stated that "in furtherance of its policy to carry on operations in the most economic fashion, has decided to enter into a Management Agreement with BP (Trinidad) Limited (British Petroleum Co.), which will take over the organization of this company and integrate it with other interests of the BP Group in the Territory. This will lead to a reduction in overhead expenditure for all operations. But the effect may be no more than to offset to some extent the recent increase in wage cost".

B.P. deals. British Petroleum Co. Ltd., has become a substantial producer in Trinidad through acquisitions of two companies in 1960 and 1961. In October 1960, it acquired Apex (Trinidad) Oilfields, Ltd., on a share exchange and cash basis. In March 1961, BP announced it would acquire Kern Trinidad Oilfields, Ltd., from Kern Oil Co., Ltd., (a wholly owned subsidiary of Rio Tinto Co. Ltd.), along with Canadian and certain U.S. holdings of Kern Oil Co. Ltd. The principal consideration will be 3 million B.P. new one-pound ordinary shares worth about 8.7 million pounds ($24.3 million). These two Trinidad companies acquired by B.P. had over 10,000 barrels per day of

OIL FIELDS IN TRINIDAD AND ADJACENT WATERS

Offshore development in the Gulf of Paria, between Trinidad and Venezuela, has been somewhat disappointing and has slowed down. Onshore work has emphasized development drilling, and crude production was increased in 1960.

TRINIDAD

production in 1960, including about 7,500 bpd for Apex and 2,800 for Kern Trinidad.

Texaco Trinidad, Inc., remains by far the largest producer in Trinidad, and Shell Trinidad, Ltd., still is second.

Marine drilling. In the spring of 1961, both the P.O.S.A. group of companies, operating in Venezuelan waters, and Dominion Oil Ltd. (a subsidiary of Standard Oil Co. of California) announced that they were about to cease drilling activity in the Gulf of Paria, Meanwhile, Trinidad Petroleum Development Co. had some doubts whether it would consummate or revise earlier plans for off-shore development, in view of a rapid decline in production of its well NM-2. After producing 30,000 barrels, its rate of output declined from 1,000 bpd to 425 bpd.

Trinidad Petroleum Development Co. planned to drill three wells in 1961 in the area under license to the company in the Gulf of Paria and one well off the South Coast. But because of delay in arrival of the drilling barge which was to do the work, the completion of all four wells during 1961 was not certain.

General. Widespread strikes occurred in the oil industry of Trinidad during 1960 when negotiations between the Oilfield Workers Trade Union and the oil companies broke down. The strikes lasted for about three weeks at the middle of the year.

During the year the Federal and Unit Governments moved further toward agreement upon a revision of the Federal Constitution, which seemed likely to lead shortly to the Federation achieving Dominion status.

Oil in 1960. Despite the various deterrents to development, Trinidad in 1960 recorded an increase of 3.2% in crude oil production and an increase in the number of wells completed, although they were shallower and involved somewhat less footage than wells of 1959. There was also a substantial increase in refinery runs, following expansion of capacity by Texaco.

Production. Trinidad's crude production averaged 115,730 bpd in 1960, an increase of 3,625 barrels or 3.2% over 1959. Output by companies is shown in Table 1, and production by fields is given in Table 2. The increase in production in 1960 was due mainly to the large build-up of output in Trinidad Northern Areas, Ltd.'s, Soldado marine area.

Secondary recovery operations by gas injection were continued by Texaco, T.P.D. and Apex. Texaco continued to inject gas into certain Forest Reserve reservoirs at a rate of 20 million cubic feet per day. T.P.D. expanded gas injection from 5 to 10 schemes during the year and was injecting about 8 mmcf per day in December 1960.

Water flooding operations were continued by Texaco in Guayaguayare and also in Forest Reserve, where some 32 injection and offtake wells were completed. Water injection increased to 11,000 bpd after commissioning the seawater line from Brighton to Forest Reserve. T.P.D. started its second waterflood scheme during the year. Shell injected 335 mmcf of gas during the year in a shallow pressure maintenance pilot project in Penal, and was preparing to start a second pressure maintenance project in the Ortoire.

Drilling and exploration. Drilling in 1960 in Trinidad involved completion of 315 wells, or 37 more than in 1959. They included 270 oil wells, 7 gas wells and 38 dry holes. Thus 87.9% of the completions were successful. Footage drilled in 1960 was 1,407,952 feet, a slight decrease from 1959, as the average per well dropped to 4,470 feet from 5,204. Wells drill-

TABLE 1—Crude Oil and Natural Gas Production and Drilling in Trinidad, by Companies

COMPANY	CRUDE OIL PRODUCTION Barrels 1960	Barrels 1959	Barrels Daily 1960	Barrels Daily 1959	Barrels Daily 1958	Natural Gas Production (Million Cu. Ft.) 1960	1959	Wells Completed in 1960 Productive	Dry	Total Wells	Total Footage	Principal Areas of Drilling	Wells Drilling End 1960
*Apex (Trinidad) Oilfields, Ltd. (British Pet. Co. after Oct. 1960)	2,741,897	2,926,805	7,491	8,018	8,610	3,308	3,479	15	7	22	.....	Fyzabad field; no exploration	3
Dominion Oil, Ltd. (Standard of Calif.)	212,861	46,594	582	128	5	2,790	517	1	4	5	.....	S. Domoil Pool; Maine area	..
C.D. Jones	1,403	1,964	4	5	.....	.....	.....	.....	.....	.....	.....	.....	..
†Kern Trinidad Oilfields, Ltd. (British Pet. Co after March 1961)	1,028,249	1,146,809	2,809	3,142	3,132	930	898	4	6	10	.....	6 wells on land, 4 marine wells	1
Premier Consol. Oilfields, Ltd.	387,158	375,192	1,058	1,028	1,147	176	1,002	8	7	15	.....	San Francique field, incl. 1 dry w. outpost of Texaco Oropouche pool	1
Shell Trinidad, Ltd.	7,205,870	7,435,519	19,688	20,371	21,909	20,093	17,683	28	3	31	165,680	.....	2
Texaco Trinidad, Inc.	17,222,517	17,688,517	47,056	48,462	43,715	39,156	40,824	106	7	113	441,921	Forest Reserve, Brighton; 2 explo. wells	6
Trinidad Central Oilfields, Ltd.	1,307,191	1,468,872	3,572	4,024	4,461	9,310	8,464	...	..	...	.....	.....	..
Trinidad Northern Areas, Ltd. (Texaco-Shell-B.P.; operated by Texaco)	6,044,583	3,772,423	16,515	10,335	5,428	5,488	3,620	23	2	25	147,078	Texaco drilling in T.N.A. area of Soldado	2
‡Trinidad Pet. Dev. Co. Ltd. (managed by British Pet. Co. after May 1961)	6,205,600	6,056,091	16,955	16,592	13,937	16,401	15,476	92	2	94	409,476	Moruga, E. & W., and exploration	5
Total	42,357,329	40,918,786	115,730	112,105	102,344	97,652	91,963	277	38	315	1,407,952	.....	20

* Apex was acquired by British Pet. Co. in Oct. 1960. † Kern was acquired by British Pet. Co. in March 1961 from Rio Tinto Co. Ltd. ‡ To be operated by British Pet. Co. under management agreement beginning about May 1961.

ing decreased to 20 at the end of 1960 from 29 a year earlier. The average number of wells drilling in 1960 was off to 27 from 30 in 1959. (Tables 1 and 3.)

Apex (Trinidad) Oilfields Ltd., carried out no exploratory drilling during the year. Four development rigs operated in the Fyzabad field until June 1960, when the number was reduced to three. A total of 22 wells was drilled, of which 15 were producers. Apex drilled two wells out of a programed profile of six wells on 1,600 foot spacing to establish correlation between the south flank of the main Fyzabad field and the Fyzabad Syncline field. Only one well was a producer.

Dominion Oil Ltd. (Standard Oil of Calif.), drilled three development wells in the South Domoil pool. Two of these (South Domoil 4 and 5) were dry. The company drilled two marine wells (Goodrich 1 and South Boundary 2) and both were dry holes. A "gas exploder" survey was completed over parts of the Gulf of Paria, and off the east coast a number of sea bottom cores were taken. Some surface investigation was carried out in the Moruga area.

During 1960 Dominion Oil Ltd. surrendered 29,612 acres of land area and 66,199 acres of its marine holdings. At mid-June, 1961, the company's holdings totaled 450,463 acres (in land and marine areas) under license, lease or option.

Follow-up drilling of Dominion Oil's South Domoil discovery, made in the Gulf of Paria in late 1959, revealed that it was a reservoir of limited extent, and further development drilling currently is suspended. Work was continuing, however, in geological and geophysical exploration and interpretation of the area.

Dominion Oil Ltd. acquired a new East Coast marine license amounting to 105,344 acres, and at mid-year was drilling on the first exploratory well, Galeota No. 1. It was spudded-in on May 2, 1961.

Kern Trinidad Oilfields Ltd., employed one rig on development drilling on land to complete 6 wells, of which 3 were producers. It drilled 5 appraisal wells in its Marine Licence from a floating barge; 2 wells were abandoned as dry holes and another was abandoned with stuck drill pipe after a blow-out. The fifth well was completed as a producer from the Nariva sands.

Premier Consolidated Oilfields Ltd., continued shallow development and outstep drilling in the San Francique field. It completed 15 wells, of which 8 were oil producers. The company drilled an exploratory well in the St. John Estate in an unsuccessful attempt to find a westerly extension of the Texaco Oropouche pool.

Shell Trinidad Ltd., operated 3 rigs until the middle of April 1960, and 2 rigs thereafter. A total of 165,680 feet was drilled, and 31 wells were completed, of which 28 were producers. Shell completed the last well (CO-89) of the second Trans-Ortoire line of regional appraisal drilling. It did not find oil bearing Herrera sands and was completed on a thin Forest gas sand. A regional appraisal well (OF-3) in the Lizzard Springs area was drilled to 8,317 feet without encountering Herrera sands.

TABLE 2—Crude Oil Production in Trinidad, by Fields

FIELD	Total Barrels in 1960	Barrels Daily 1960	Barrels Daily 1959
Brighton-Vessigny & adjacent marine areas	3,226,298	8,815	7,071
Forest Reserve-Apex-San Francique-Point Fortin East.	11,525,332	31,490	33,858
Guayaguayare	2,051,419	5,605	3,437
Kern-Parrylands-Cruse	1,815,713	4,961	5,638
Palo Seco-Los Bajos	5,041,114	13,773	14,979
Penal-Barrackpore	3,465,840	9,469	9,864
Point Fortin-Pt. Ligoure	1,402,414	3,832	4,852
North Marine	29,980	82	.....
Soldado Marine	5,818,683	15,898	10,335
South Domoil	212,861	582	128
Quarry-Coora-Quinam-Morne Diablo	2,931,810	8,010	8,898
Moruga East	123,495	337	476
Moruga West	1,383,733	3,781	1,927
Balata-Bovallius	141,043	385	423
Catshill	1,234,726	3,374	3,699
Oropouche	189,920	519	633
Inniss/Trinity-Moruga North.	1,762,948	4,817	5,888
Total, Trinidad	42,357,329	115,730	112,106

TABLE 3—Wells in Trinidad in 1960, 1959, and 1958

(Completed, Drilling, Producing, and Shut in.)

ITEM	1960	1959	1958
Wells Completed	315	278	295
Oil	270	244	256
Gas	7	3	.....
Dry	38	31	39
% Successful	87.9	88.8	86.8
Footage Drilled	1,407,952	1,446,586	1,365,129
Average Depth	4,470	5,204	4,628
Wells Drilling at End of Year	20	29	29
Average During Year	27	30	32
Wells Producing at End of Year	3,148	3,261	3,300
Wells Shut In at End of Year	2,586	2,198	.....

TABLE 4—Refining in Trinidad

ITEM	Bbls. Daily
Capacity, 1960	285,000
Texaco	235,000
Shell	50,000
Average Throughput, 1960	223,806
Capacity, 1959	190,000
Texaco	140,000
Shell	50,000
Average Throughput, 1959	189,600

It was completed on a thin Lower Cruse gas sand. An experimental seismic survey in the Ortoire area was commenced in November.

Texaco Trinidad, Inc., operated an average of 8½ rigs throughout the year to drill a total of 441,921 feet. It completed 113 wells, of which 7 were dry holes. Most of the drilling was concentrated in the Forest Reserve and Brighton areas. In the former, outstep development drilling continued in the Palo Seco Grande Ravine field and on the south flank of Forest Reserve field. A total of 17 wells was completed, with 1 dry hole. In the Brighton area 18 wells were drilled on the Brighton Platform, and two of them were dry holes. In addition, four successful marine outstep wells were completed, using a floating barge. Development drilling was also carried out in the Barrackpore, Trinity and Rock Dome fields, and in Guayaguayare further development took place in the Navette pool, discovered in 1959.

Texaco, in the Trinidad Northern Areas, Ltd., area of Soldado, completed 25 wells, 2 of which proved dry. One platform rig and one mobile rig operated throughout the year, but a second platform rig was not in continuous operation. A total of 147,078 feet was drilled. Texaco, as operator of Trinidad Northern Areas, Ltd., in the joint Texaco, Shell, B.P. marine area of Soldado, drilled six appraisal wells during the year, using a mobile unit, and one was drilling at year end. Of these, four wells were drilled to establish production west of the main developed area. Three were successful and one was abandoned as a dry hole. Two wells were drilled as outsteps east of the main developed area. One was successful, and the other was abandoned. One well, north of Los Bajos fault, was drilling at the end of the year.

Trinidad Petroleum Development Co. Ltd., maintained seven rigs for the first 8 months and five rigs for the last four months, with a basic distribution of one rig continually on exploratory or semi-exploratory drilling. Two rigs were employed on development drilling in the Moruga West field, and at first four and later two development rigs in the main fields. A total of 409,476 feet was drilled during 1960, which was 46,000 feet or 13% more than in 1959, due largely to shallow drilling in the Moruga West field; and 94 wells (10

TRINIDAD

more than in 1959) were completed, of which 92 were producers.

T.P.D. completed one exploratory well on land, and two were drilling at year end. The completed well (Mackenzie 6) did not establish commercial production in the deeper Cruse section, but was successfully completed in the Lower Forest sands. This well and Mackenzie 7, drilling at year end, were designed to test the succession down to the base of the Cruse sands south of Los Bajos fault. The second well (MN-146) drilling at year end had as its objective the Herrera sands in the thrusted structure of the Rock Dome anticline. Two appraisal wells (P.S. 463 and 467) were drilled in the Palo Seco field to explore the deeper Lower Cruse prospects, and in March 1961, they had failed to define commercial accumulations, but testing was continuing. Two shallow appraisal wells (Qu. 232 and 233) were successful in proving extensions of the shallow Lower Cruse productive horizon of Qu. 205 drilled in 1959 in South Quarry. In the North Marine off-shore lease, NM-2 successfully established production north of Los Bajos fault, but attempts at evaluation have not so far established that it can be obtained in commercial quantities. The well has had a rapid decline in production. One field party carried out coring in the Tableland area for six months, intermittently, during the year.

Argentina . . . crude and natural gas output expected to meet needs

In 1961, for the first time, Argentina's annual production of crude oil and natural gas is expected to be sufficient to meet domestic requirements. Output of crude amounted to 62,898,000 barrels in 1960, an average of 171,852 barrels daily. This was nearly 40,000 bpd or 30 percent more than production in 1959 of 132,112 bpd.

Since Argentina reached self-sufficiency in December, 1960, the government intends to increase production, so as to continue to export oil to Uruguay, while importing only limited amounts of special products.

Projects now under way or planned to assist the nation's burgeoning oil industry include expansion of Argentina private company operations on a contract basis with Yacimientos Petroliferos Fiscales (YPF), the government oil entity; expanded activities in exploration and development operations by domestic and non-Argentine companies working for YPF; and development of additional new port facilities and tanker fleet expansion.

Development underway. Under way at mid-1961 were three new re-

Crude Oil Production in Argentina in 1960, by Companies

COMPANY	Total Barrels in 1960	BARRELS DAILY 1960	BARRELS DAILY 1959	% Diff.
Yacimientos Petroliferos Fiscales	45,729,966	124,945	111,217	+ 12.3
L-R Development, Inc.	2,775,000[1]	7,582[1]	7,598	— 0.2
Diadema Argentina S A de Petroleo (Royal Dutch Shell Interests)	3,144,900	8,593	7,516	+ 14.3
Pan American International Oil Corp.	7,079,654	19,343	1,773	+991.0
Esso Sociedad Anonoma Petrolera Argentina (Standard N.J. affiliate), including Esso Argentina Inc., exploration affiliate	91,867	251	408	— 38.5
Tennessee Argentina S. A.	1,671,684	4,567	.....	.....
Others	2,404,929	6,571	3,600[1]	+ 82.5
Total, Argentina	62,898,000	171,852	132,112	+ 30.1

[1] Estimated.

fining and processing plants, a 23,000 barrel-a-day products pipe line from Mendoza to the western Buenos Aires province, a new oil shipment facility near La Plata, improvement of oil loading facilities at Buenos Aires, Santa Cruz and Tierra del Fuego; and further development work in Catriel producing fields at Neuquen.

Contributing heavily to Argentina's new position of self-sufficiency in crude oil has been Pan American International Oil Co., subsidiary of Standard Oil Co. (Indiana).

Pan American, which operates in Comodoro Rivadavia under a 20-year contract with YPF signed in 1958, calling for development of an area on the north flank of the San Jorge basin, reported production of about 37,000 barrels a day early in 1961. During 1960 the company produced 7,079,654 barrels, or almost 20,000 bpd compared with only 1,773 bpd in 1959.

YPF No. 1 Producer. Of course, YPF remained the leading crude producing company. Its production in 1960 of 45,729,966 barrels or 124,944 bpd was an increase of 12.3 percent over the 111,217 bpd of 1959.

Diadema Argentina S A de Petroleo, third ranking crude producer, last year recovered 8,592 bpd, up 14.3 percent from the 7,516 bpd of 1959.

Tennessee Argentina, S. A., which operates under a 1959 exploration-development contract with YPF on almost 3.5 million acres located on Tierra del Fuego island, was credited with production in 1960 of 4,567 bpd. However, Tennessee's production has been limited by weather and lack of adequate transportation facilities. The company's production has since reached as high as 15,000 to 20,000 barrels per day. Tennessee's principal fields are La Sara and Arroyo Gama.

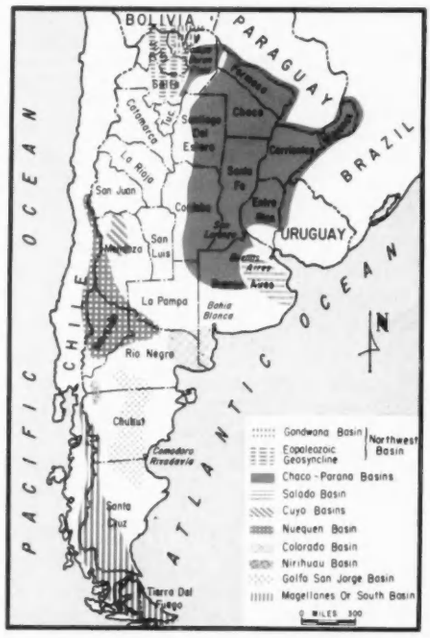
Esso Sociedad Anonoma Petrolera Argentina and Esso Argentina Inc., the exploration affiliate, last year produced 91,867 barrels or 251 bpd, a decrease of 38.5 percent from 408 bpd in 1959.

Esso Argentina Inc. is the entity which is carrying out exploration activities in the Neuquen area under terms of a development contract signed with YPF late in 1958. This company is constructing and financing a 14-inch crude pipe line from the Neuquen area (Challacó) to Bahia Blanca (Puerto Rosales) for the account of YPF. Esso S. A. Petrolera Argentina is the older of the two companies, having been in Argentina for 50 years. It has some small production operations in the Neuquen area and owns and operates four refineries, a river fleet, and marketing and distribution facilities.

At the close of 1960, Esso S. A. Petrolera Argentina reported one flowing well and 23 pumping wells, with 45 producing wells shut in. Its production totaled 75,565 barrels, or 206 bpd. Production of Esso Argentina Inc. amounted to 16,302 barrels, or 45 bpd.

At mid-1961 it appeared probable that during the second half of the year all private refineries would be operating on domestic crude oil, except for some small amounts of specialty crudes. Imports of distillates and lube oils are expected to continue due to product imbalance.

ARGENTINE SEDIMENTARY BASINS



Bolivia... Gulf discovers major field north of Santa Cruz. Chaco finds oil near southern border

In Bolivia President Victor Paz Estenssoro was elected for a second term in 1960. In his previous term he had nationalized the mining industry and divided farms by an agrarian reform. Both measures resulted in a continued decline of production and economic trouble. But he had encouraged oil development and enacted the new petroleum law of 1955.

Because of the precarious financial situation and political unrest, oil production by Yacimientos Petroliferos Fiscales Bolivianos (YPFB), the Government agency, has declined continuously in recent years. Its output of crude declined from 9,413 bpd in 1958 to 8,685 bpd in 1959 and 8,498 bpd in 1960.

However, exploration and drilling by private companies, which entered Bolivia in 1956, after enactment of the new petroleum law, have been very active. The three most active companies are Gulf Oil Co. of Bolivia; Chaco Petroleum Co., subsidiary of Tennessee Gas Transmission Co., and its associates, and Bolivian Oil Co. of the Fish Engineering group. Their investment is estimated to have exceeded $50 million. Commercial production was attained by the private companies for the first time in 1960. In August it reached about 2,800 bpd. For the year, after starting only in April, it averaged 1,267 bpd.

Production. YPFB's crude production in 1960 amounted to 3,110,439 barrels or 8,498 bpd, against 3,170,115 barrels or 8,685 bpd in 1959. Bulk of the output was supplied, as in former years, by the Camiri and Guairuy fields, which yielded 7,215 bpd against 7,280 bpd in the previous year, or around 85% of the total output.

Output of the Bermejo-Toro fields in the south, on the Argentine border, declined slightly from 1,319 bpd to 1,228 bpd. The small Sanandita field yielded only 55 bpd against 86 bpd in the previous year. Efforts to increase production in Sanandita by further drilling so far have been unsuccessful.

Cumulative output of YPFB is nearing 30 million barrels. Reserves of the Camiri field have been calculated at about 70 million barrels.

Among the private companies, commercial oil is produced only by Bolivian Oil Co., which operates the Madrejones concession of around 100,000 acres on the Argentine boundary east of Yacuiba. Its output from two producing wells was estimated at 3,000-4,000 bpd. The oil was exported to Argentina. The new

pipeline from the neighboring Campo Duran field to San Lorenzo refinery in Argentina, 926 miles long, was constructed by the same Fish Engineering group at a cost of more than $200 million. Bolivian Oil Co., besides a cash bonus of $1½ million and an advance of $2½ million, to be repaid in oil, pays a royalty of 50% to YPFB, the owner of the concession area.

Drilling. YPFB in 1960 completed 29 wells, 3 more than in 1959, of which 23 yielded oil and six were dry. Total footage amounted to 122,333 feet, around 12% less than in the previous year. Average depth was about 4,200 feet. At the end of the year seven rigs were active, of which five were for extension and exploration.

The private companies completed a total of 14 wells, of which four produced oil, with a total footage of 130,983 feet. They were drilling six wells at the end of 1960.

Private companies. Exploration and drilling by the private companies was accelerated in 1960.

Bolivian Gulf Oil Co., the largest concession holder and most active, completed seven wildcats.

In Mandyapecua on the northern continuation of the Carandaiti structure, on the border of the Chaco, located on seismic surveys, the third well was abandoned at 6,285 feet. All three wells were dry.

Wildcat Mitigua 1 in the Camiri area, to the southeast of Camiri, was abandoned at 12,017 feet.

Victoria 1 and Victoria 2, farther to the southeast, drilled to 7,236 and 7,009 feet respectively, were dry.

Well Boyuibe, about 30 miles southeast of Camiri, was abandoned at 12,784 feet.

Two producing wells were completed in 1960 by Gulf Oil at Caranda in the Santa Cruz region, about 30 miles northwest of Santa Cruz. Well Caranada 1, of 14,036 feet final depth, yielded 325 bpd of 50° API oil at a depth of some 5,850 feet. Well Caranda 2, of 8,245 foot depth, yielded reportedly about 450 bpd. This was the first success of Gulf after an intense drilling campaign of 20 wells with a footage of more than 150,000 feet at an expenditure of reportedly $30 million.

OIL FIELDS AND PIPE LINES OF BOLIVIA

On May 9, 1961, T. A. Kibby, manager of Gulf Oil Corporation's Western Hemisphere exploration headquarters in Coral Gables, Florida, announced that his company apparently had discovered a major new field in Bolivia. He stated that a well on the nearly 10 mile long Caranda structure had been tested at a rate of 1,570 barrels per day of 51 degrees gravity oil through a ½-inch choke from a total depth of 3,600 feet.

Kibby stated that a very thick oil sand was present in the interval tested; and while the total thickness had not yet been determined, it appeared to be over 100 feet.

Gulf Oil holds a block of 1¼ million acres in the vicinity of the Caranda structure, which is in eastern central Bolivia, about 30 miles northwest of the city of Santa Cruz.

Gulf Oil also drilled in the Izozog area in the lowlands of Santa Cruz department, farther east. It drilled eight stratigraphic tests to depths of around 3,000-5,000 feet each in 1960, and continued drilling there in 1961.

Chaco Petroleum Co., subsidiary of Tennessee Gas, continued drilling in the former McCarthy concession, on the Agua Salada thrust on the Chaco border, without success in 1960 but with success in 1961. Well Agua Salada 2 was abandoned in February 1960 at 14,956 feet. Wildcats Palo Marcado 1 and 2, completed at 11,983 feet and 11,790 feet, were abandoned later on in 1960.

On May 25, 1961, in Houston, an oil and gas discovery in southern Bolivia was announced by Chaco Petroleum, S.A., as operator of a 443,400-acre lease held jointly by Chaco and three other Bolivian subsidiaries of U.S. companies.

A drill stem test from one zone indicated gas condensate and oil production, and a test from another zone indicated gas condensate production. Information as to rates of production would not be available, Chaco stated, until the completion of final testing, which was then in progress. Total depth of the well was 12,890 feet. Full evaluation of the magnitude of the discovery was due to be determined by further exploratory drilling

Designated Algarrobilla No. 1, the well was approximately 40 miles northeast of the town of Yacuiba, located on the Bolivian-Argentine border.

Participants in the lease, in addition to Chaco Petroleum, a subsidiary of Tennessee Gas Transmission Company of Houston, are the Bolivian subsidiaries of Union Texas Natural Gas Corporation and of Lion Oil Company, a division of Monsanto Chemical Company, both also headquartered in Houston, and of Murphy Corporation of El Dorado, Arkansas.

Chaco Petroleum so far has drilled a total of more than 60,000 feet.

Crude Oil Production and Drilling in Bolivia in 1960, by Companies and Fields

Company and Field	Crude Oil Production in 1960 (Bbls.)		Producing Wells at End of 1960			Wells Completed in 1960					Wells Drilling End of 1960
	Total	Daily	Flowing	Artificial Lift	Total	Oil	Gas	Dry	Total	Footage	
YPFB*											
Camiri & Guairuy	2,640,817	7,215	69	18	87	13	..	6	19	85,571	5
Sanandita	20,056	55	..	7	7	..	..	..	..	107	1
Bermejo and Toro	449,566	1,228	15	16	31	10	..	..	10	36,655	1
Total YPFB	3,110,439	8,498	84	41	125	23	..	6	29	122,333	7
Other Companies	463,693	1,267	2	..	2	4	..	10	14	130,983	6
Total Bolivia, 1960	3,574,132	9,765	86	41	127	27	..	16	43	253,316	13
Total Bolivia, 1959	3,170,115	8,685	93	20	113	21	1	8	30	189,670	19

* Yacimientos Petroliferos Fiscales Bolivianos.

Bolivian Oil Co. had completed its two first wells in the Madrejones area at the end of 1959 as producers, with a yield of 1,900 bpd and 1,400 bpd respectively. The company in 1960 completed its well Madrejones 3 at 13,699 feet and Madrejones 4 and 6 at 13,922 and 13,675 feet. Madrejones 4 and 6 are expected also to be producers. Potentials of the Madrejones wells are estimated at about 3,000 bpd per well. Bolivian Oil has drilled so far a total footage of about 70,000 feet.

Atlantic Refining Co. and Bolivian Petroleum Co., subsidiary of Drillexco of Dallas, Texas, are expected to start drilling in Bolivia this year in a joint venture.

Bolivia California Petroleum Co., a subsidiary of Standard Oil Co. of California, and Compania Petrolera Boliviana Shell, Ltd., have acquired an additional five petroleum concessions covering 114,750 hectares or 283,547 acres, in Petroleum Zone No. 1 in Bolivia. The concessions are located about 50 kilometers or 31 miles east of the city of Santa Cruz. They are adjacent to other concessions held by the two companies and on which a well currently is being drilled.

The rig that is drilling the well received wide publicity late in 1960. Built largely of special alloys of aluminum and magnesium, the rig, which is capable of drilling to depths of from 12,000 to 15,000 feet, depending upon hole size, is designed to be transported by helicopter or cargo plane, thus avoiding extremely high road building costs in many otherwise inaccessible locations.

For the first time since enactment of the new petroleum law, private companies have achieved a substantial production, which should increase considerably in the future.

Local demand of the country has remained low, estimated at scarcely 6,000 bpd. The surplus has been exported principally to Argentina.

In the Comisión Mixta area, west of Santa Cruz, which was divided between YPFB and private Brazilian interests, the three newly formed Brazilian companies, Petroleo de Bolivia, Uniao-Brasil and Petróleo Andino, have started surveys. They are expected to operate through American contractors.

Brazil... Government is expected to expand output from most promising areas and to curtail wildcatting

ECONOMIC POLICY in Brazil entered upon a radical change with the unexpected, overwhelming victory in the elections for independent President Janio Quadros. As governor of the state of Sao Paulo he had proved his ability as an efficient administrator.

Rapidly growing inflation had pushed the free exchange rate to about 250 cruceiros per dollar. One of the new President's first measures was to adjust the official rate to the real value. As one of the most important products, the preferential import rate for petroleum of 100 was doubled to 200. That caused, of course, a considerable increase in the local prices of gasoline and other petroleum products.

Future oil policy in Brazil probably will be strongly influenced also by statements of Walter Link, American oil exploration consultant of high standing and exploration chief for the past six years for Petroleo Brasileiro (Petrobras), the government oil company. He stated that the vast exploration and drilling program of Petrobras in recent years, costing about $300 million, had indicated poor prospects of oil in Brazil, with exception of the Bahia area and the narrow belts of marine Cretaceous ingressions on the Atlantic coast. The statements cast doubt on the advisability of continuing an expensive program of oil exploration in the less promising regions of Brazil. (Table 1 and map.)

Bahia Fields. However, the active oil developments of Petrobras in recent years has achieved very important results by rapidly increasing the output of the Bahia fields. In 1960 they produced 29,612,676 barrels, an average of 80,909 barrels daily. (Table 2.)

The Bahia production provides a perennially increasing proportion of the domestic demand. The domestic use in 1960 was calculated at 94 million barrels or 257,500 bpd. The domestic production therefore fulfilled almost one third of the demand.

Further expansion of production is indicated, moreover, as proved reserves of the Bahia fields have been increased. They now are estimated in excess of 600 million barrels. That amount is 20 times the annual production of 1960, and could be expected to support considerably more production than that now being obtained.

These facts doubtless will cause the new, realistic government to revise the national oil policy. To meet the petroleum requirements of the country, the government is likely to put emphasis on expansion of domestic output from the most promising areas and to recognize the need for imports on the most convenient and favorable conditions.

In regard to imports, a significant development was the government's barter agreement with Russia. That country agreed to deliver 5.4 million barrels of crude for the national refineries, probably below world market prices, in exchange for Brazilian products, of which coffee was the most important.

There is no reason to expect a change of attitude regarding foreign oil companies. For those companies, like Petrobras, would have difficulty in finding oil, facing the same geological conditions and facts.

Production. Output of the Bahia fields in the Reconcavo Basin increased 25% in 1960, to 29,612,676 barrels or 80,909 bpd from 64,486 bpd in 1959. In December it once reached 100,000 bpd. New discoveries in the Reconcavo area in Sauipe, Sao Sebastiao and Ouricanguinhas extended the Bahia fields, and output was rising steadily.

Drilling has been very active. (Table 3.) There were 55 rigs operating at the end of the year, 29 for exploration and 26 for development. The number of wells completed in 1960 was 233, with a total footage of 1,052,741 feet. Of the wells completed, 124 yielded oil and 109 were dry.

But among the 140 development wells only 21 were dry and 119 were producers. For 93 exploration wells, the footage totaled 565,421 feet, considerably exceeding the 487,320 feet for the 140 development wells. Of the 93 exploratory wells, only 5 in the Reconcavo basin struck oil and 88 were dry.

In the Amazon Basin the lenticular sandstone intercalations in the lower

EXPLORATORY WELLS DRILLED IN BRAZIL TO SEPTEMBER 1960

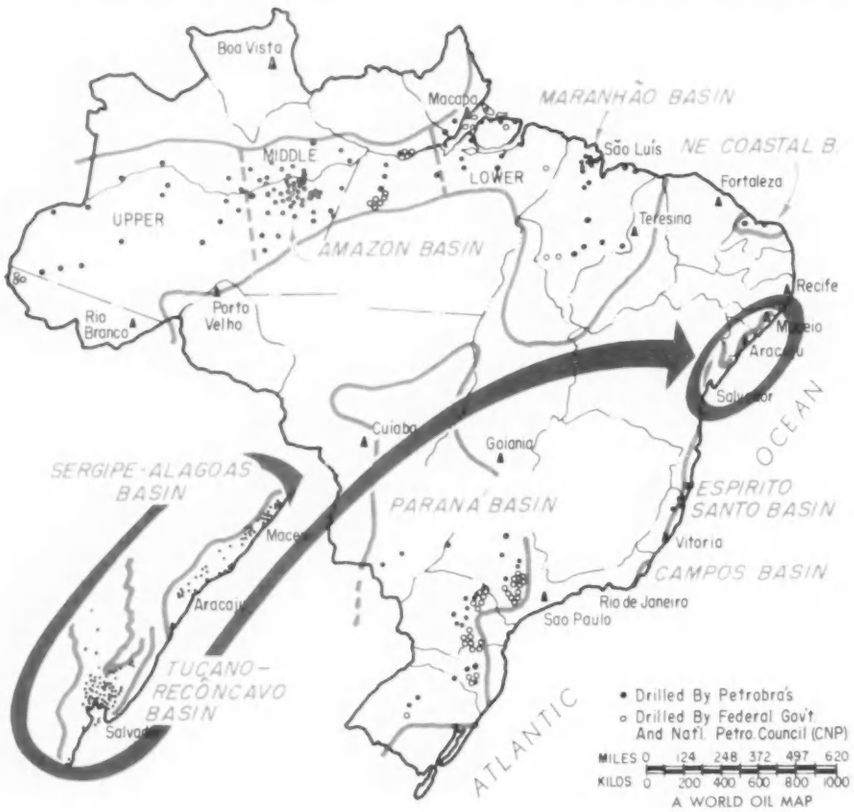


TABLE 1—Averages of Ratings of Basins in Brazil by Seven Petrobras Geologists in 1960

LOCATIONS OF BASINS ARE SHOWN ON MAP HEREWITH

(Ratings are defined as follows: A. Commercial production established; exploration should be continued. B. Has all requisites for petroleum; geological factors indicate that commercial oil should be found; continued active exploration warranted. C. Marginal; much exploration; no commercial success. D. No possibilities; exploration should cease. For averaging, A equals 1, B equals 2, C equals 3, and D equals 4.)

Basin	RATING Letter	RATING Number	Recommendation
Lower Amazon	D	3.8	Exploration should be discontinued.
Middle Amazon	C+	2.8	Exploration should continue on a reduced rate.
Upper Amazon	C—	3.5	Exploration should be discontinued.
Acre	D+	3.1	Exploration should be discontinued.
Sao Luiz Maranhao	D+	3.6	Exploration should be discontinued.
Barreirinhas Maranhao	C	3.1	Oil possibilities unfavorable. Chances of finding bonanza oil are very poor. Exploration not geologically advisable.
Maranhao	C	3.2	
Sergipe Land	B+	1.9	Full scale exploration should continue.
Alagoas Land	C	3.4	Oil possibilities unfavorable. Chances of finding bonanza oil are very poor. Exploration not geologically advisable.
Tucano	..	....	Increasing activity is recommended.
Reconcavo	A	....	Full scale exploration should continue.
Espirito Santo, South Bahia	D	3.8	Exploration should be discontinued.
South Brazil	C—	3.4	Oil possibilities unfavorable. Chances of finding bonanza oil are very poor. Exploration not geologically advisable.

TABLE 2—Crude Oil Production and Oil Wells in Brazil

Year	Bbls. Production Total	Bbls. Production Daily	Oil Wells Completed in Years	Oil Wells Completed-All Years	Producing Oil Wells Year End
1960	29,612,676	80,909	124	737	686*
1959	23,537,430	64,486	128	613	562
1958	18,923,738	51,846	82	485	336
1957	10,106,267	27,688	50	403	174
1956	4,058,703	11,089	32	353	127
1955	2,013,705	5,517	33	321	...

* Estimate.

TABLE 3—Wells Drilled in Brazil

ITEM	Wells Completed Oil	Gas	Dry	Total	Footage	Drilling Year End
1960						
Total Wells	124	.....	109	233	1,052,741	55
Wildcats	5	.....	88	93	565,421	29
Field Wells	119	.....	21	140	487,320	26
1959						
Total Wells	128	.....	101	229	910,372	30
Wildcats	6	.....	86	92	493,034	17
Field Wells	122	.....	15	137	417,338	13
1958						
Total Wells	82	2	56	140	688,698	31
Wildcats	5	1	50	56	427,168	.....
Field Wells	77	1	6	84	261,530	.....
1957						
Total Wells	50	2	38	90	409,215	30
Wildcats	.....	.....	.....	.....	197,165	.....
Field Wells	.....	.....	.....	.....	212,050	.....

Devonian Curua formation, which had aroused such big expectations through the Nova Olinda discovery in 1954, proved non-commercial, being rapidly depleted. In the overlying Monte Allegre formation, which could have provided a suitable reservoir rock, only oil shows at Auta Mirim were struck. No prolific source bed had been found in the underlying Devonian.

In the Parana Basin in the south, lava sheets of the Serra Geral formation, up to several thousand feet thick, cover most of the area. Paleozoic outcrops are restricted to a marginal belt in the east. A number of unsuccessful wells have been drilled.

The only oil shows and some initial production have been found in the Alagoas and Sergipe coastal belt.

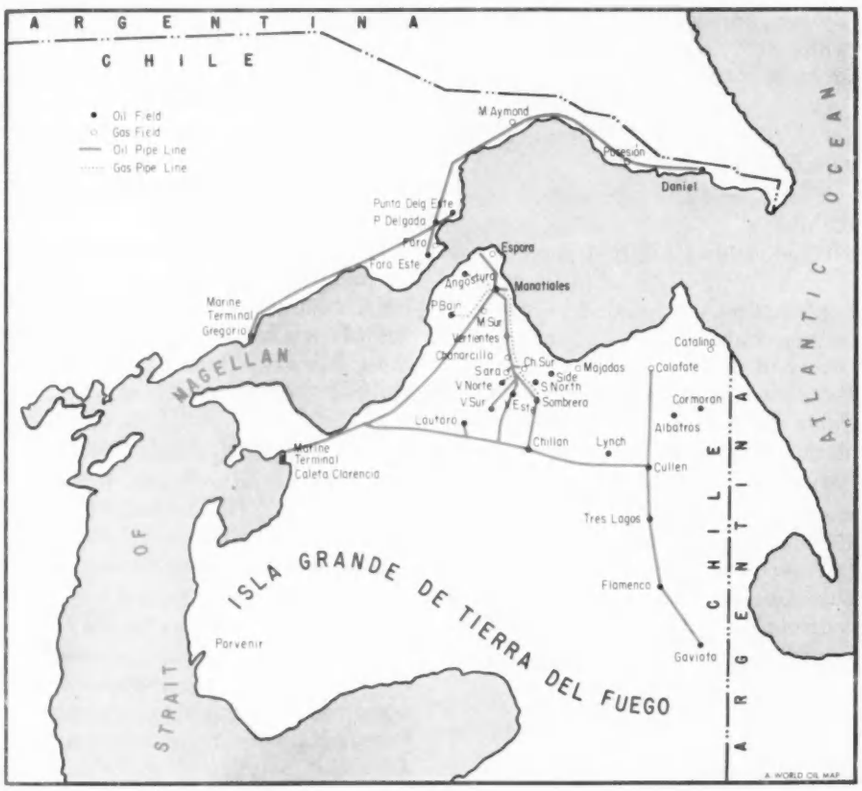
Over 200 wildcats have been drilled in Brazil in the past several years, without proving oil in any new area. Poor prospects were offered from the beginning by the geological position on the Brazilian Shield, with only a comparatively thin cover of mostly continental deposits and shallow marine Paleozoic basins, the importance of which has often been exagerated for political or commercial reasons.

Exploration. At the end of 1960 Petrobras was carrying out exploratory work with 10 geological exploration crews, 12 seismic crews and 7 gravity crews.

The refining capacity of Brazil amounts to nearly 200,000 bpd. It was sharply increased by the inauguration of the Duque de Caxias refinery near Rio de Janeiro, on January 20, 1961. That refinery has a capacity of 90,000 bpd. It will greatly reduce the need of foreign exchange for import of oil products.

Brazil is still exchanging its too-waxy crude, which runs about 95° pour point, with Standard of New Jersey for better blending crudes. The Brazilians have a salt problem and must maintain desalting facilities at their refineries.

OIL AND GAS DEVELOPMENT IN CHILE



Chile... crude output above 20,000 bpd; refinery runs near 30,000. New fields are discovered

THE POLITICAL AND ECONOMIC situation in Chile remained stable in 1960. However, the extremely strong earthquakes in May 1960 on southern Chile's Pacific coast devastated a great part of its agricultural region and seriously damaged important centers of population, such as Concepción and Valdivia. The quakes caused a severe interruption of the development of the country.

There was a continuance of steady progress in oil development of the country, conducted by Empresa Nacional del Petroleo (ENAP), the Government agency, which in June 1960, observed its tenth anniversary. Oil output increased from 17,611 bpd in 1959, to 19,756 bpd in 1960, and in April 1961, reached 22,064 bpd. Refinery runs were nearly doubled from 945,297 cubic meters or 5,945,729 barrels (16,290 bpd) in 1959, to 1,659,514 cubic meters or 10,438,011 barrels (28,519 bpd) in 1960.

The oil discovery on the mainland, north of Magellan Strait, was further extended to the east by the new findings of Daniel and Posesión. Oil exploration in northern Chile was continued; and at beginning of 1961, the first well in northern Chile was spudded at Pintados, about 50 miles southeast of Iquique.

Production. Crude production increased from 6,428,151 barrels in 1959, to 7,230,779 barrels (1,149,604 cubic meters) in 1960, an increase of 12.5%. Increase from the daily average of 19,756 bpd in 1960, to 21,979 bpd in February 1961, means a new 11.3% rise.

Half of the output in 1960 was supplied by the Cullen field, which yielded 3,613,427 barrels (9,873 bpd), or 574,490 cubic meters. In Cullen a new gas plant is being constructed at a cost of $5 million, with the Hudson Engineering Corp. acting as consultants. It will treat about 98 million cubic feet of gas daily. The plant will produce propane, butane and natural gasoline. It will also be used for stabilization of crude and repressuring. It is expected to be on stream by early 1962.

Output of Cullen field increased in 1960 nearly 40% over 1959. Cumu-

TABLE 1—Crude Production, Producing Wells, and Drilling in Chile, by Months

MONTH	Fields Producing	Crude Oil Production During Month		Wells Producing At End of Month			Wells Completed During Month					Rigs Active, End of Mo.
							Wells				Total Footage	
		Total Barrels	Bbls. Daily	Flowing	Artificial Lift	Total	Oil	Gas	Dry	Total		
1961:												
January	..	673,631	21,730	118	..	118	3	..	1	4	26,387	4
February	..	615,413	21,979	131	..	131	3	..	2	5	40,357	4
March	..	683,550	22,050	....	..	....	5	1	1	7	46,636	4
April	..	.....	22,064	....	..	....	..	..	..	..	.....	..
1960:												
January	..	584,308	18,849	92	..	92	1	..	3	4	27,604	4
February	..	549,192	18,938	94	..	94	2	..	1	3	25,190	4
March	..	588,930	18,998	99	..	99	1	..	1	2	23,602	4
April	..	571,774	19,059	99	..	99				5	39,150	4
May	..	591,914	19,094	97	..	97	8	2	3	5	27,506	4
June	..	572,844	19,095	96	..	96				3	41,047	4
July	..	588,675	18,990	101	..	101				5	37,923	4
August	..	613,532	19,791	104	..	104	8	3	6	7	39,005	4
September	..	623,326	20,778	114	..	114				5	41,266	4
October	..	649,894	20,964	115	..	115				6	43,172	4
November	..	634,263	21,142	114	..	114	8	2	7	7	33,412	4
December	..	662,127	21,359	125	..	125				4	32,670	4
1960, Total	..	7,230,779	19,756	125	..	125	28	7	21	56	411,547	4
1959, Total	31	6,428,151	17,611	92	8	100	26	15	49	90	620,412	5
1958, Total	24	5,567,883	15,254	94	8	102	28	10	36	74	494,134	5

Conversion factors: 1 cubic meter = 6.2898 barrels; 1 meter = 3.2808 feet.

lative output of Cullen field since its discovery in 1954 has reached 10.6 million barrels, or nearly 1/3 of the total cumulative output of the Magellan fields.

Sombrero field declined slightly to 154,188 cubic meters or 969,812 barrels (2,650 bpd) in 1960. It has yielded the second largest cumulative output of nearly 8 million barrels.

The Victoria fields yielded 107,076 cubic meters or 673,490 barrels (1,840 bpd) in 1960, almost equal to the previous year, and have had a cumulative output of about 6.1 million bbls.

Punta Delgada field, on the mainland north of the Magellan Strait, yielded 91,644 cubic meters or 576,422 barrels (1,575 bpd). That was 10% more than in the previous year. The newly discovered Daniel pool, the most eastern discovery on the continent, yeilded 8,654 cubic meters or 54,435 barrels total (149 bpd).

Cumulative output of the Magellan fields, including 1960, amounts to around 35 million barrels. The Cullen, Sombrero and Victoria fields have yielded about 24.7 million barrels, or more than 70% of the total.

Drilling. The number of wells completed declined sharply to 56 in 1960 from 90 in 1959. But the success rate was considerably higher, because 28 wells, or exactly 50%, yielded oil, 7 gas and 21 were dry. Four rigs were active and 125,441 meters or 411,547 feet were drilled, against 620,412 feet in 1959. Average depth was 7,349 feet. One of the rigs was destined for directional drilling beneath the Magellan Strait, where oil had been proved in the sea, offshore Faro Este.

For development, 23 wells with combined depths of 48,468 meters or 159,014 feet were drilled, of which 18 yielded oil, 2 gas and 3 were dry. Of 21 extension wells with depths totaling 43,170 meters or 141,632 feet, 7 yielded oil, 4 gas and 10 were dry. Twelve wells were completed for exploration at depths totaling 33,803 meters or 110,901 feet. Three of them yielded oil, 1 gas and 8 were dry.

Although wells and footage drilled in 1960 were considerably lower than 1959, the success rate was much higher, and oil output increased almost as sharply as in 1959.

Since discovery in 1945, there have been 571 wells drilled in the Magellan fields, of which 221 yielded oil, 88 gas and 262 were dry. The dry holes constituted less than 46%. The total included 289 wells for development, 135 for extension and 147 for exploration.

Gas production in 1960 amounted to 2,193,811 cubic meters or around 77 million cubic feet.

There were 125 wells producing at the end of 1960, all flowing, with an average yield of 171 bpd per well.

Exploration. Continued exploration on the continent resulted in the discovery of oil at Daniel and of gas at Possesión, both farther east from Punta Delgada on the northern shore of the Magellan Strait.

Daniel looks like the best oil field on the mainland so far. As of April 1, 1961 ENAP had completed 19 wells (all vertical), including 16 oil producers and 3 dry holes. From the control obtained so far, it appears that Daniel will be about a 100-well field, with about 80 of the wells under water south of the present offshore wells. There is a shoal 3 miles offshore from which about 20-directional wells might be drilled. But operations will be difficult because of normally bad weather and the nine-knot tidal currents that go through the strait, in one direction in the morning and in the other during the afternoon.

Farther east from Daniel along the coastal frontier strip with Argentina, ENAP has found the Posesión gas field. It is a large field but yields very dry gas. Unlike Daniel, which is all in Chile, Possesión may straddle the Argentine border.

Up to April 1, 1961, ENAP had completed 15 oil wells and 4 dry holes at Faro Este. This includes some directional holes offshore. Faro Este and Punta Delgada Este fields may merge.

Geological and seismic surveys continued in the Magellan region, and 3 geological and 4 seismic parties were active. In September 1960, a wildcat was spudded some 50 miles north of Puerto Natales. It was between Lago Toro and Sarmiento, in the foothills of the Cordillera farther north. It was scheduled to be drilled to about 7,000 feet.

In northern Chile in the province of Tarapaca, after geological and seismic surveys carried out since 1956, the first well was spudded on January 9, 1961. It was Pintados 1, located 4 miles from the railway station of Pintados and about 50 miles southeast of Iquique. The well, drilled by Loffland Bros. as contractors, had reached in April a depth of 2,200 meters or 7,200 feet. It reportedly encountered lava beds below 1,600 meters or 5,250 feet.

In the province of Atacama another wildcat was being drilled by Santa Fe Drilling Co. at Pedernales, on the west edge of Salar de Pedernales, apparently a salt flat. In April, Pedernales 1 was drilling at about 1,000 meters (3,281 feet).

Several wells will be drilled at both Pintados and Pedernales. For this purpose, ENAP reportedly has appropriated $1.5 million.

The total budget of ENAP for 1961 has been indicated as $37 million.

Pipe lines. A total of 145 miles of oil and gas pipe lines was built in Chile in 1960.

The Faro Este and Punta Delgada fields on the mainland have been con-

TABLE 2—Crude Oil Production in Chile, by Fields

FIELD	Total Barrels		Barrels Daily	
	1960	1959	1960	1959
Manantiales	123,821	127,494	338	349
Sombrero	969,812	1,042,251	2,650	2,856
Victoria	673,490	678,217	1,840	1,858
Chanarcillo	476,402	295,923	1,301	811
Chillan	265,775	271,996	726	745
Cullen	3,613,427	2,605,807	9,873	7,139
Vertientes		173,517		475
Flamenco	158,374	95,932	433	263
Tres Lagos		424,650		1,163
Calafata	318,821	190,342	871	522
Punta Delgada	576,422	522,022	1,575	1,430
Daniel	54,435		149	
Total Chile	7,230,779	6,428,151	19,756	17,611

Conversion factor: 1 cubic meter = 6.2898 barrels.

TABLE 3—Development and Exploratory Wells Drilled in Chile in 1960

Class	Oil	Gas	Dry	Total Wells	Footage
Development	18	2	3	23	159,014
Extension	7	4	10	21	141,632
Exploratory	3	1	8	12	110,901
Total, 1960	28	7	21	56	411,547
Total, 1959	26	15	40	90	620,412

TABLE 4—Cumulative Number of Wells Drilled in Magellan fields of Chile, Including 1960

Results	Wells
Oil	221
Gas	88
Dry	262
Total	571

nected by an 8-inch pipe line of 34 miles length with the new maritime terminal at Gregorio, on the northern coast of the Magellan Strait, for shipping the oil of the continent. The line started operation in July 1960.

ENAP in April 1961 had a pipe line connection for the new Daniel oil field under way. It will be an 8-inch line 75 kilometers or 47 miles long, from Daniel to the existing facilities at Faro Este, which tie in with the terminal at Gregorio. The Daniel line was due to be completed by mid-year 1961. It was expected to add about 6,000 bpd to Chile's production. With that addition, Chile would be producing about 28,000 bpd.

Refining. Chile's refinery runs increased in 1960 to a total of 1,659,514 cubic meters or 10,438,011 barrels, an average of 28,519 bpd. During the year, 1,089,690 cubic meters or 6,853,-932 barrels (18,727 bpd) of domestic crude were processed, or nearly 66% of the total. Meanwhile, 569,824 cubic meters or 3,584,079 barrels (9,793 bpd) of crude were imported from Venezuela.

Domestic demand for petroleum in Chile is estimated at 44,000 bpd, and it is increasing by about 7% yearly.

OIL FIELDS AND PIPE LINES OF COLUMBIA

Colombia... important discoveries made. Crude output up 4 percent

COLOMBIA'S CRUDE OIL output increased in 1960 by about 4% to 55,770,445 barrels (official figure) or 152,378 bpd, against 146,778 bpd in 1959. Development was marked by completion of the first producing well in eastern Colombia. It was Texas Petroleum Co.'s Guavio wildcat, 65 miles east of Bogota in the Llanos foothills. Santos field was discovered in the middle Magdalena Basin by British Petroleum-Sinclair Exploration Co., which had entered the country only in 1959. Shell's Cristalina discovery has possibilities of being enlarged.

In late May 1961 a significant multi-pay oil discovery was made by Colombia-Cities Service Petroleum Corp.'s wildcat, Payoa 1, in the middle Magdalena Valley, 30 miles northeast of Barranca-Bermeja and 160 miles north of Bogota.

The economic situation was stable. But the free dollar rate rose anew to about eight pesos per dollar in the early months of 1961, while the oil dollar was quoted at 6.50, a 20% difference.

In March 1961, a new petroleum law was enacted, amending the 1931 law substantially. Surface rentals, which previously were paid in pesos, are payable now in dollars. Because of the devaluation of the Colombian currency, this means a considerable increase. Higher income for the Government from this provision is expected by the Minister in the amount of about $20 million. Royalty, which formerly varied for the different regions, is fixed at a stable 14½%. Area of the concessions is reduced to half, to 25,000 hectares (61,775 acres) for western and 100,000 hectares (247,100 acres) for eastern Colombia. After discovery of commercial oil the concession area must be reduced by 50%, the reverting area being offered anew for better bids. The drilling obligation is doubled. The depletion allowance is reduced. However, the Government declares that the new law only aims at a just 50-50 split and will be fair to oil development.

The attitude toward foreign capital has remained friendly.

Production. Crude output in Colombia during 1960 averaged around 155,000 bpd, and in July reached a high of 160,387 bpd. But due to a strike in Colombian Petroleum Co.'s fields, it fell sharply in August and September, and the yearly average was reduced to only 152,378 bpd. In January 1961, crude output amounted to 152,739 bpd and in February 1961, to 145,611 bpd.

Largest producer in 1960 remained Colombian Petroleum Co. (Mobil-

COLOMBIA

Texas), which averaged 45,710 bpd. The Cicuco field in the lower Magdalena, discovered only in 1956, almost equalled the output of the Barco concession, yielding 22,297 bpd, compared with 23,378 bpd of the Barco concession. In January 1961, total output of Colombian Petroleum amounted to 48,508 bpd. The Cicuco field, which yields 44.4 million cubic feet of gas daily, is being connected by a gas line of 140 miles length with Barranquilla. The line was built at a cost of $8 million by Colombian Petroleum and national interests, for supplying an important source of energy to the principal port of Colombia.

Texas Petroleum Co. remained second producer, with 40,133 bpd. Its Velasquez and Palagua fields in the upper Magdalena Basin yielded 38,134 bpd of the total.

Shell slightly raised its output to 38,524 bpd. The Casabe (Yondo) and San Pablo fields yielded 35,036 bpd of the total.

Empresa Colombian de Petróleos, the Government agency, maintained its output from the De Mares concession at the same level, obtaining in 1960 a daily production of 27,467 barrels. The De Mares concession up to January 1, 1960, has yielded over 500 million barrels. The contract with Forest Oil Co. of Pennsylvania, which drilled a great number of wells for secondary recovery by water flooding, was cancelled by Empresa, and Forest suspended drilling in October 1960. Operation of the 37,500 bpd refinery at Barranca Bermeja, the largest refinery of Colombia, was taken over on March 31, 1961, by Empresa. Previously, after the former Tropical Oil holdings, reverted to the government, the refinery had continued to be operated by International Petroleum Co. Empresa announced plans for an investment of $70-80 million in 1961 for enlarging its operations.

Output of International Petroleum Co. of Colombia remained small at 339 bpd. International reportedly has spent about $78 million in unsuccessful exploration in Colombia since the world war.

United Fruit Co.'s Lebrija field yielded 203 bpd.

At the end of the year, 2,143 wells in Colombia were producing, of which 153 were flowing and 1,990 pumping, with an average yield of 71 bpd, about the same as in the previous year.

Drilling. The number of well completions was considerably lower than in 1959. A total of 158 wells, plus 15 stratigraphic tests were completed; 79 of them yielded oil, five gas and 74 were dry, plus 15 dry stratigraphic tests of Texas Petroleum Co.

Of 47 wells for exploration, 13 yielded oil, four gas and 30 were dry. Of 111 development wells, 66 yielded oil, one gas and 44 were dry, including 32 for water injection. Total footage amounted to 1,043,692 feet, against 1,205,382 in 1959. Discounting the footage of 80,349 feet of the 15 stratigraphic tests, average depth of the exploration wells with a total footage of 379,100 feet was around 8,000 feet, and of the development wells with a total footage of 584,243 feet nearly 5,300 feet.

Highest number of wells was completed in the De Mares concession. But of 69 wells completed, 45 with a total footage of 171,790 feet were drilled by Forest Oil Co. for secondary recovery. Texas Petroleum Co. drilled 23 development wells, nine for exploration and 15 stratigraphic tests.

Shell reduced drilling to nearly half, completing 11 wells against 21 in 1959, and was reported considering further reduction of drilling.

At the end of 1960, 13 rigs were

TABLE 1—Crude Oil Production, Producing Wells, and Drilling in Colombia in 1960 and 1959

Company and Field	Crude Oil Production: Barrels in Year 1960	Barrels in Year 1959	Barrels Daily 1960	Barrels Daily 1959	Barrels Cumulative Through 1960	*Producing Wells at End 1960	Wells Completed 1960	Wells Completed 1959	Footage Drilled 1960	Footage Drilled 1959	Wells Drilling End 1960
Shell Condor S. A.	**14,099,192**	**13,622,494**	**38,524**	**37,322**	**181,649,742**	**440**	**11**	**21**	**104,221**	**149,208**	**2**
Casabe (Yondo)	7,670,854	8,279,810	20,959	22,684	149,285,511	399	...	...	.....	.....	..
Cantagallo	921,561	912,803	2,518	2,501	8,759,879	11	...	...	.....	.....	..
San Pablo	5,152,096	4,091,155	14,077	11,209	15,629,371	22	5	...	.....	.....	..
Difficil	277,634	338,726	759	928	7,897,934	8	...	...	.....	.....	..
La. Cristalina	77,047	.....	211	.....	77,047	....	...	...	.....	.....	..
Exploratory Wells	.....	.....	.....	.....	.....	....	6	...	.....	.....	..
Empresa Colombiana de Petroleos: De Mares (incl. wells of Forest)	**10,052,850**	**9,876,888**	**27,467**	**27,060**	**516,447,175**	**1,152**	**69**	**44**	**331,580**	**172,215**	**2**
Colombian Petroleum Co. (Mobil-Texas)	**16,729,953**	**15,215,894**	**45,710**	**41,687**	**176,667,751**	**307**	**29**	**33**	**165,429**	**179,020**	**2**
Barco	8,556,606	9,103,045	23,378	24,940	159,318,978	288	13	...	.....	.....	..
Cicuco	8,160,579	6,109,504	22,297	16,738	17,332,660	19	6	...	.....	.....	..
Violo	12,768	3,345	35	9	16,113	....	...	...	.....	.....	..
Exploratory Wells	.....	.....	.....	.....	.....	....	10	...	.....	.....	..
Texas Petroleum Co.	**14,688,818**	**14,716,601**	**40,133**	**40,320**	**70,559,106**	**217**	**47**	**66**	**287,865**	**351,776**	**3**
Velasquez	10,099,759	10,430,513	27,595	28,577	54,213,021	115	16	...	.....	.....	..
Palagua	3,857,344	3,569,410	10,539	9,779	12,432,762	91	3	...	.....	.....	..
Tetuan	463,559	462,253	1,267	1,266	3,075,676	3	1	...	.....	.....	..
Ermitano	220,322	203,215	602	557	663,621	7	2	...	.....	.....	..
Sogasmoso	40,934	49,493	112	136	165,409	1	...	...	.....	.....	..
Baul	6,900	1,717	18	5	8,617	....	1	...	.....	.....	..
Exploratory Wells	.....	.....	.....	.....	.....	....	9	...	.....	.....	..
Stratigraphic Tests	.....	.....	.....	.....	.....	....	15	...	.....	.....	..
International Petroleum Co.	**124,270**	**81,969**	**339**	**224**	**935,689**	**6**	**9**	**10**	**110,229**	**60,046**	**3**
Totumal	34,439	40,152	94	110	360,493	....	...	...	.....	.....	..
Aguachica	53,543	22,477	146	62	494,468	....	...	...	.....	.....	..
Others	36,288	19,340	99	52	80,728	....	...	...	.....	.....	..
Exploratory Wells	.....	.....	.....	.....	.....	....	9	...	.....	.....	..
Compania Petrolera Nueva Granada (United Fruit): Lebrija	**74,414**	**59,493**	**203**	**163**	**138,229**	**4**	...	**5**	.....	**51,214**	..
Amkirk Petroleum Corp. Floresanto	**948**	**773**	*2*	*2*	**2,313**	....	...	**1**	.....	.....	..
Cities Service Colombia	.....	.....	.....	.....	.....	....	**2**	**7**	**21,298**	**59,814**	..
Richmond Oil Co. (Standard of Calif.)	.....	.....	.....	.....	.....	....	...	**2**	.....	**19,689**	..
Colombian Sun Oil Co	.....	.....	.....	.....	.....	....	...	**1**	.....	**10,569**	..
Forest Colombian Corp.	.....	.....	.....	.....	.....	....	...	†29	.....	**142,505**	..
John W. Mecom	.....	.....	.....	.....	.....	....	**6**	...	**23,070**	**9,326**	**1**
Total, Colombia	**55,770,445**	**53,574,112**	**152,378**	**146,778**	**946,400,005**	***2,143**	**173**	**219**	**1,043,692**	**1,205,382**	**13**

* Total of 2,143 on Dec. 31, 1960, included 153 flowing 1,990 on artificial lift. Data shown here by companies and fields are as of July 31, 1960, and total 2,126 wells. † Water injection wells.

active in Colombia, including seven for exploration and six for development, against a total of 22 at the end of 1959. In mid-March 1961, a total of 17 rigs were drilling, of which 13 were in exploration work.

Exploration. Exploration has been active and more successful than in 1959. Most important discovery was British Petroleum-Sinclair's Santos 1 wildcat, drilled on a farmout from International Petroleum Co., in the middle Magdalena Valley, to 9,960 feet. From two pay zones it yielded 1,000 bpd of 32-36° API crude, and potential was reportedly estimated at double that amount. British Petroleum extended the discovery by well Santos 2, which yielded 980 bpd, and wildcats Conde 1 and 2, on another nearby farmout from International, which were being completed as producers in the spring of 1961.

British Petroleum proposes to connect this field by a pipe line, and according to a statement of the Minister of Mines, the company plans to invest $50 million in Colombia. As British Petroleum is a company controlled by a foreign government, the provisions of the petroleum law have been modified for legalizing its operation.

Shell's Cristalina 3 discovery of 1959, located in the same area but farther west, was successfully enlarged by well Cristalina 4 with an initial yield of 1,200 bpd of about 29° API crude.

In early June 1961 Colombia-Cities Service Petroleum Corp. was dually completing its important discovery well Payoa 1, about 30 miles northeast of Barranca-Bermeja in the middle Magdalena Valley, 160 miles north of Bogota. The well was on the east edge of a 75,000 acre block out of 2 million acres being explored by this company and its associates, Ecopetrol (the Colombia government oil company), Richfield Oil Corporation, and Pan-American International Oil Corp., each having a 25% interest. Substantial reserves were indicated by flows of oil up to 92 barrels per hour from each of five separate oil horizons between 6,900 and 8,400 feet.

At 6,895-6,929 feet Payoa 1 flowed 94 barrels of 23.1 gravity oil through a ½ inch choke in 1½ hours. At 6,952-6,999 feet it flowed 130 barrels of 23.9 gravity oil through ½ and ¼ inch chokes in 2½ hours. From 7,742-7,764 feet the well flowed 29 barrels of 27.7 gravity oil through ½ inch choke in 6 hours. From 7,932-7,958 feet it flowed 56 barrels of 29.3 gravity oil through a ⅜ inch choke in 4 hours. From 8,278-8,388 feet it flowed 920 barrels of 35.0 gravity oil through various sized chokes in 10 hours.

TABLE 2—Results of Drilling in Colombia in 1960

Class of Wells	Wells Completed in 1960				
	Oil	Gas	Dry	Other	Total
Wildcats	13	4	30	..	47
Development Wells	66	1	44	..	111
Stratigraphic tests	..	..	..	15	15
Total	79	5	74	15	173

John Mecom of Houston continued drilling in the Caribbean area, where he struck gas in the Tolu concession, in association with Empresa, and spudded well Tolu 6. He also discovered gas in the Jobo farmout from International in wells Tablon 3 and Jobo 4, proving a total of some 10 million cubic feet of gas daily.

Colombian Cities Service Co., after no commercial findings in Chucuri, struck oil in Aguas Claras. But it has not had an outlet for the oil because of lack of pipe line connections. It drilled two wells in 1960.

Sun Oil Co. of Colombia withdrew after unsuccessful drilling in the Sinu Basin, in the Provincia block in middle Magdalena, and in Uraba in the most western part of the country, near the boundary with Panama. Shell also drilled a wildcat at Uraba, which hit basement at 2,020 feet.

Ambassador Oil Co. of Fort Worth drilled two wildcats in the coastal area near Barranquilla, Campito 1 and 2, which were abandoned.

Empresa Colombiana, the Government company, in its wildcat Llanito 7 in the De Mares concession reportedly got a potential yield of 3,000 bpd in a test. The well was drilled to 8,105 feet depth.

In eastern Colombia's Llanos region, in the footbills of the Cordillera east of Bogotá, Texas Petroleum Co. has completed its Guavio 1 wildcat, drilled to 10,592 feet. In two different sands at about 7,000 feet, 540 bpd of crude were recovered. Texas later was drilling its Guavio 2 well.

This discovery means the first finding of oil in eastern Colombia, where a considerable number of stratigraphic tests had been drilled. The Heliera wildcat of Mobil and Shell in the northern Llanos near the Venezuelan border, completed the previous year, had been dry at 8,961 feet, having reached Paleozoic rocks of the basement. Shell's Tame 1 wildcat, also in the northern part of the Llanos, was abandoned at the end of 1960 at 13,920 feet, having been dry.

The Magdalena Basin continued yielding the bulk of Colombia's oil output. And only in the Magdalena Valley have new fields been added, including the new discoveries of Shell's Cristalina, British Petroleum's Santos, and Colombia-Cities Service's Payoa wells. Cities Service's Aguas Claras wells also were located in the middle Magdalena. In the lower Magdalena Basin Cicuco of Colombian Petroleum has proved a big field of high grade oil, and Difficil field of Shell yields a moderate output also of high grade crude.

Colombian Petroleum Co.'s Barco concession in the Maracaibo Basin is gradually declining, and second recovery is being applied on a growing scale.

In the Caribbean area only gas has been proved by Mecom in the Tolu, Tablon and Jobo discoveries.

In the Tertiary coastal belt on the Pacific Coast the deep wildcats of Richmond in Buchadó in the north and of Mobil Oil in Chagui near Tumaco in the south were unsuccessful, and no new exploration has started since.

In eastern Colombia's Llanos region the Guavio wildcat of Texas Petroleum Co. yielded a moderate output of some 500 bpd. Its location only 65 miles east of Bogotá may permit transportation to the capital of Colombia, which consumes about half of the domestic demand. But the deep wildcats at La Heliera and Tame, near the Venezuelan Barinas Basin, were dry.

Colombia's cumulative production including 1960, amounts to around 950 million barrels of crude. Its present proved reserves have been calculated at about 700 million barrels.

Domestic demand for products exceeds one third of the output, being indicated around 55,000 bpd. Exports increased to 31,331,722 barrels or 85,606 bpd in 1960, with a value of $80 million.

Mobil Oil Co. acquired 65% of the stock of the Colombian CODI firm, which shares the marketing in Colombia with Esso, Shell and Texaco.

Ecuador... exploration is extended to north along coastal belt as Santa Elena production declines

ECUADOR'S CRUDE OIL PRODUCTION further slightly declined to 2,798,920 barrels or 7,647 bpd in 1960, from 2,822,955 barrels or 7,734 bpd in 1959. Anglo-Ecuadorian Oilfields Ltd., in which Lobitos Oilfields Ltd. in London and Standard (N. J.) hold the controlling share, remained the principal producer, with an output of 6,963 bpd, slightly higher than in the preceding year. Tennessee del Ecuador, subsidiary of Tennessee Gas Transmission Co., the second producer, recovered 250,231 barrels total or 684 bpd.

But domestic demand is almost double domestic production and amounted to about 12,000 bpd in 1960. Refinery runs of the new refinery of Anglo Ecuadorian at La Libertad, and the topping plant of Tennessee in its Cautivo field rose to 11,599 bpd in 1960.

The attitude toward foreign companies is friendly and taxes are low. The highest royalty, which gradually declines according to distance from the coast, is fixed at 11%. A new petroleum law is being drafted.

The only producing area has remained the Santa Elena peninsula. Anglo-Ecuadorian's Ancon field and Tennessee's Tigre field yield the bulk of the production from the Paleocene Atlanta sands at 4,500-5,000 feet. However, exploration has been extended to the large prospective Tertiary coastal belt to the north, extending to the Colombian boundary.

Tennessee del Ecuador has drilled two wildcats in Manabi in the region of Manta, of which one yielded gas shows, but both were abandoned. Drilling in the Esmeraldas region, where more than 10 years ago International Petroleum Co. drilled two wildcats at Camarones, southwest of Esmeraldas, and at Borbones, south of Limones, was projected by Standard Magnetite Co. of New York.

In the Daule Basin of the Daule River, Tennessee drilled two wildcats in the region of Balzar. They were dry and reportedly hit basement.

In the coastal area, Tennessee holds about 3 million acres of concessions, in which geological surveys were active. California del Ecuador, subsidiary of Standard of California, held a concession area of similar extent and carried out extensive geological and geophysical surveys. California drilled two offshore wells in the Gulf of Guyaquil to depths of 4,400 feet and 4,107 feet. One reportedly yielded oil shows, but both were abandoned. On Puna Island, in the Gulf of Guyaquil, California drilled another wildcat, which struck basement, and the company reportedly suspended operations.

East of the Gulf of Guyaquil and the mouth of the Guayas River, Agrippa, subsidiary of United Fruit Co., has applied for around 1½-million acres of concessions.

The National Company, which in 1960 applied for a concession of more than 7 million acres, extending from southern Ecuador to the Esmeraldas region in the north, proposed to start operations jointly with Standard Magnetite Co. of New York. Besides, several national concessionaires and Tradewinds Exploration Inc., hold smaller acreage in the region from west of Guyaquil to Santa Elena. Otto Carbo drilled a well, which was abandoned because of technical difficulties.

Although the concession area in Ecuador's coastal region is large, very few and only widely spaced wells have been drilled. They do not permit definite conclusions on the oil prospects.

In the Ecuadorian Oriente, east of the Andes in the Amazon Basin, Shell, later on associated with Standard N. J., had carried out extensive exploration and drilled 6 wildcats before ceasing operations in 1950. In that area a new company, Minas y Petroleos del Ecuador S.A., was granted a concession, called Pastaza, covering about 10.8 million acres. It extends from the foothills of the Andes to the Napo River in the north and the Peruvian boundary in the east. The concession has been taken over by NORSUL Oil & Mining Ltd., of Calgary, Canada.

OIL FIELDS OF ECUADOR

OIL FIELDS OF SANTA ELENA PENINSULA OF ECUADOR

Production and Drilling in Ecuador in 1960 and 1959, by Companies

COMPANY*	Crude Oil Production		Wells Producing at Year End			Wells Completed During Year					Wells Drilling Year End
	Total Bbls.	Bbls. Daily	Flowing	Art. Lift	Total	Oil	Gas	Dry	Total	Footage	
1960											
Anglo-Ecuad.	2,548,689	6,963	21	1,485	1,506	64	..	2	66	178,807	5
Tenn. del Ec.	250,231	684	1	196	197	2	..	6	8	31,676	1
Calif. Ec. Pet.	.....	.....	..	....	....	..	..	2	2	5,928	..
Otto Carbo	.....	.....	..	....	....	..	..	1	1	753	1
Total	2,798,920	7,647	22	1,681	1,703	66	..	11	77	217,164	7
1959											
Anglo-Ecuad.	2,492,220	6,828	31	1,362	1,393	19	..	..	19	79,826	3
Tenn. del Ec.	330,735	906	24	174	198	2	..	8	10	26,139	2
Total	2,822,955	7,734	55	1,536	1,591	21	..	8	29	105,965	5

* Company names are abbreviated as follows: Anglo-Ecuad., Anglo-Ecuadorian Oilfields, Ltd.; Calif. Ec. Pet., California Ecuador Petroleum Co.; Otto Carbo; Tenn. del Ec., Tennessee del Ecuador S.A.

Production. Anglo-Ecuadorian, including Carolina Oil Co. and Petropolis Oil Co. in Santa Elena, both operated by Anglo-Ecuadorian, produced about 90% of the total output. Tennessee del Ecuador's output has sharply declined from 1,916 bpd in 1958, to 906 bpd in 1959, and 684 bpd in 1960, and drilling has been unsuccessful.

In January 1961, total output of Ecuador increased to 8,199 bpd, including 612 bpd by Tennessee, and in February to 8,275 bpd.

California Ecuador Petroleum Company, a subsidiary of Standard Oil Company of California, during 1960 surrendered all of its remaining holdings and interests in Ecuador.

Drilling increased in 1960 by more than 100% to 77 completions from 29 in the previous year. Also, footage was more than doubled to 217,164 feet against 105,965 feet in 1959. The number of successful oil completions increased to 66 from 21 in the preceding year. Seven rigs were active at the end of 1960.

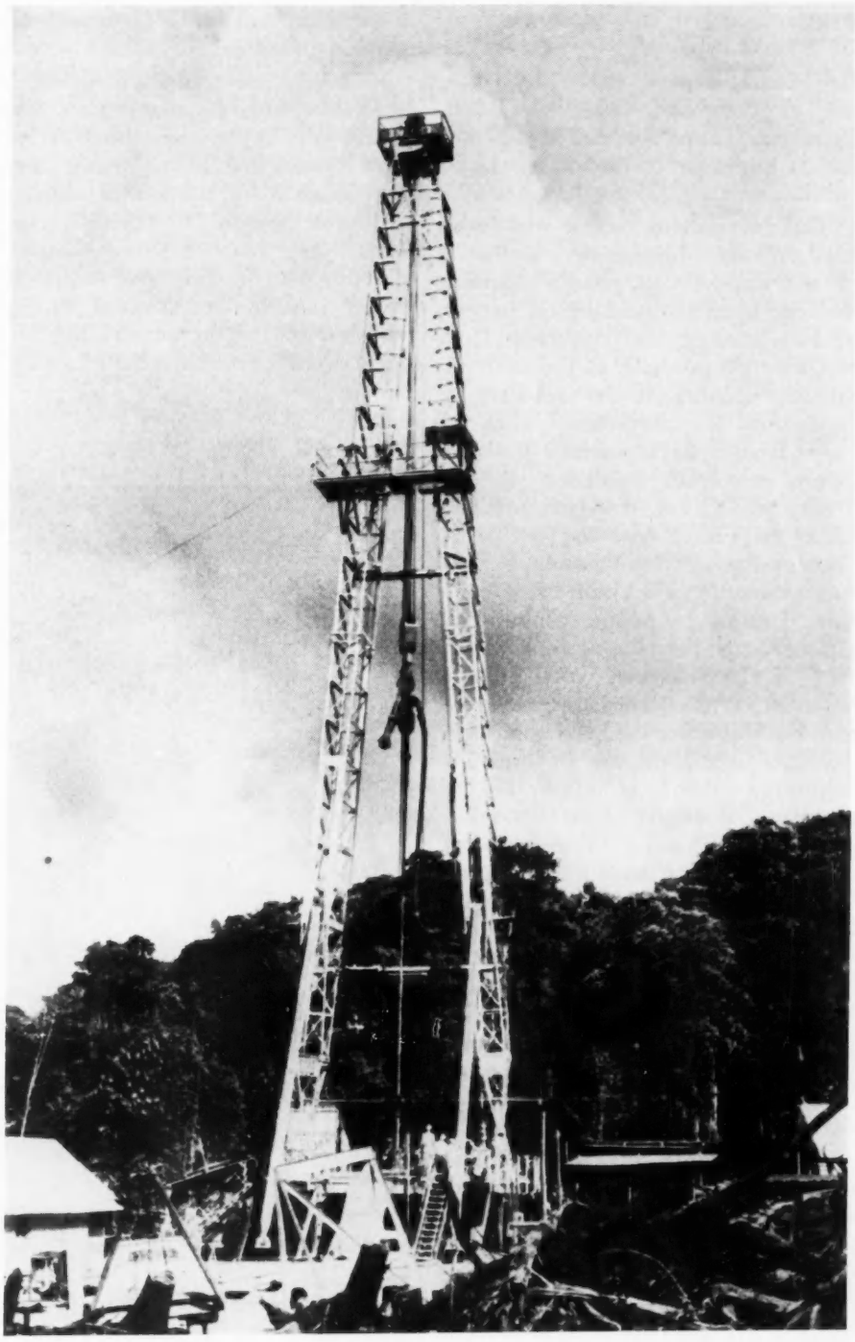
The total number of producing wells at the end of 1960 was 1,703, of which 22 were flowing and 1,681 were operated by gas lift or pump. But average yield per well was less than 5 barrels daily. The total included 1,506 wells of Anglo-Ecuadorian and 197 wells of Tennessee.

Guianas... more aerial surveys are made

THE GUIANAS were typical of a number of the world's small and only mildly oil-prospective areas in which interest ebbed, due to the worldwide oil glut, in 1960 and 1961.

California Oil Co. (British Guiana) Ltd., an affiliate of Standard Oil Co. of California, dropped its license on 16,000 square miles of coastal and offshore British Guiana on April 15, 1960.

Aero Service Corp. and Canadian Aero Service were engaged in a detailed follow-up in 1961 of the 66,000-square-mile reconnaissance survey in Surinam (Dutch Guiana) flown in 1960. This survey provided aeromagnetic, scintillometer and aerial photographic coverage in a general over-all minerals survey for the Surinam Ministry of Development.



In late May 1961, Cerro de Pasco Petroleum Corp. was drilling below 9,120 feet in its wildcat on the Iscozazin structure, a faulted anticline in the Amazon basin, central eastern Peru. Iscozazin River is a tributary of Palcazu River, an affluent of the Pachitea, on which the Ganso Azul field is located, about 100 miles to the north. Cerro de Pasco's mines in the high mountains to the west consume about 450,000 barrels per year (or 1,233 daily) of petroleum products. The company's need for fuel is the reason for its oil search.

Peru... active year is recorded in 1960. Drilling doubles and crude oil production rises 8.4 percent

PERU'S OIL DEVELOPMENT showed remarkable progress in 1960. Crude output increased by 8.4% to 52,609 bpd. Number of completed wells was more than doubled. Exploration and development on the continental shelf continued actively, and for the first time a significant output of 155,899 barrels (426 bpd) was recovered from offshore wells. In eastern Peru's Amazon Basin drilling was renewed for the first time since discovery of

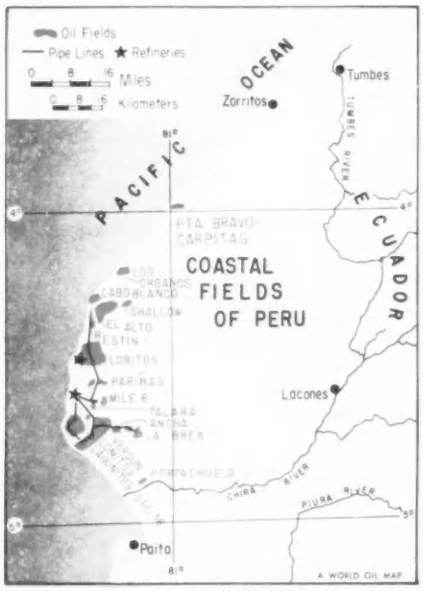
the Maquia field in 1957. Mobil Oil Co. of Peru and Cerro de Pasco Petroleum Corp. spudded two wildcats at beginning of 1961 in the Ucayali Basin.

This encouraging picture was darkened only by continued severe attacks of the oppositional political parties and one of the principal local papers against International Petroleum Co., the principal producer of the country, and the validity of its Brea-Pariñas concession. This concession, dating its rights from a land purchase in 1888 before petroleum legislation, by an arbitration act of the International Court of The Hague in 1922, had been exempted from taxation, except surface rentals, a decision often considered unjust by public opinion. On enactment of the new petroleum law in 1952, International requested adjustment of its concession to the new law, but this never has been approved. In September 1960, the Government submitted a draft of a new bill to Congress. It would grant the company a new 30 years concession, with possible extension for 10 years more; but after this period all oil wells and fixed installations, including the 45,000 bpd. refinery at Talara, should revert without indemnity to the Government. This plan would be similar to that applied to the elapsed concession of Tropical Oil Co., another subsidiary of Standard N.J., in Colombia.

However, this proposed new law was made particularly onerous by additional changes, such as an additional payment of 300 million soles (about $11 million); an additional bonus of $34,750,000, payable in yearly installments during the new concession term; an income tax split of 60-40 in favor of the Government, instead of the 50-50 split of the oil law of 1952; no depletion allowance, 15% being granted by said oil law; reduction of the Brea-Pariñas concession by 66,456 hectares (164,213 acres) to an extension of only 100,000 hectares (247,100 acres); and other previous provisions, including a reinvestment of 50% of the profits and limitation of exports to 20% of the output. International Petroleum Co. agreed to a revision of its concession conditions, but has objected to a considerable reduction of its acreage and to a taxation which may make further development uneconomic.

However, last spring the new bill had not yet been debated in Congress, and it was hoped that the Government would find an equitable solution, which would not hamper further oil development. The industry has yielded large benefits for the country and provided its principal source of energy. The present government administration has improved the economic situation of the country, stabilized the currency, balanced the budget, encouraged foreign investments, and created a surplus in Peru's balance of payments.

OIL FIELDS OF PERU



Production. Peru's crude output increased in 1960 by 8.4% to 19,255,034 barrels or 52,609 bpd, against 17,725,847 barrels or 48,564 bpd in 1959, exceeding also the figures of the several preceding years. An amount of 18,084,625 barrels or 49,411 bpd came from the coastal area; 1,014,520 barrels from eastern Peru's Amazon Basin, from the Ganso Azul and Maquia fields; and 155,889 barrels from offshore wells on the continental shelf. Besides, 902,265 barrels (2,465 bpd) of natural gasoline were recovered from Brea-Pariñas and Lobitos fields.

Bulk of production was provided by International Petroleum Co. with a total output of 16,778,306 barrels or 45,842 bpd. Brea-Pariñas field declined slightly from 8,223,956 barrels or 22,531 bpd in 1959 to 8,083,274 barrels or 22,085 bpd in 1960. Secondary recovery by repressuring and water flooding maintained the output on its high level after 60 years of oil extraction; 65 wells for gas injection and 92 wells for water flooding were operated at the end of year, and 8 new wells for water injection were drilled in 1960.

Highest increase of output was shown by the Lobitos fields, operated also by International Petroleum Co., which owns a 50% undivided share. By activated drilling, particularly to the deeper sands of the lower Eocene Salinas formation at 6,000-7,000 feet, yield increased to 8,695,032 barrels or 23,757 bpd, about 1,160,000 barrels more than in 1959. Lobitos fields contain the principal reserve for future improvement. Output in January 1961 amounted to 769,600 barrels, or 24,826 bpd.

Recovery of natural gasoline in Brea-Pariñas field amounted to 692,244 barrels total, with an average recovery of 1.37 gallons per 1,000 c f of gas, and to 210,021 barrels in Lobitos with an average of 1.40 gallons.

Output of Empresa Petrolera Fiscal, the Government oil company, increased by some 4% to 968,590 barrels total or 2,646 bpd against 2,544 bpd in 1959. This came from its small Organos field, which had yielded a cumulative output of

11,584,879 barrels to Jan. 1, 1960. Operation of Zorritos field, the oldest oil field in Peru, where drilling started in 1865, has ceased almost completely.

Output of the farmout of Peruvian Pacific Petroleum Co., east of Lobitos area, amounted to 2,637 barrels total. The property was returned to Empresa early in 1960, restricting Peruvian Pacific's operation to the continental shelf.

Belco Petroleum Corp. of New York, which acquired the holdings of Petrolera Peruana in 1959, intensified drilling with 3 rigs, operated by South American Drilling Co., and made considerable investments. It raised output from 77,870 barrels in 1959 to 379,190 barrels in 1960, obtaining a significant part from wells inclined offshore from the coast. Its production at the end of 1960 exceeded 2,000 bpd, and amounted in the early months of 1961 to around 1,900 bpd.

Petrolera Amotape, subsidiary of Amotape Oil, Inc., discovered a new pool of productive Verdun sands at only some 1,200 feet near the coast. But drilling was suspended, and output remained stagnant, declining slightly to 64,970 barrels total. Higher investments are required for drilling to the deeper prospective sands.

One well, drilled by Douglas Oil Co. of California, which withdrew several years ago, and now operated by Lobitos Oil Co., yielded some 10,000 barrels total (27 bpd).

Continental Shelf. Development on the continental shelf was active. Peruvian Pacific Petroleum Co., subsidiary of Cities Service, and Richfield Oil Corp., continued drilling in deeper waters with the drilling boat Rincon, exceeding 6,000 feet of drilling depth. Well Humboldt 3-3, 1,000 feet deep and yielding about 200 bpd, was connected by a submarine pipe line, 6,200-feet long, from the wellhead in 132 feet water depth, with the storage tanks on the coast. The line saved the heavy expense of a marine platform. It was similar to a system developed recently by Shell in Louisiana. Peruvian Pacific's output from the shelf amounted to 35,830 barrels in 1960.

Considerably higher output was obtained from offshore wells of Belco Petroleum Corp. It completed 7 inclined wells from the coast, which were all productive. Besides, by leasing the drilling boat Rincon from Peruvian Pacific, it drilled two producing wells in deeper waters offshore Talara. By submarine pipe lines, one nearly 9,000 feet long, they were connected with the coast. Belco's output from its offshore wells amounted to 120,059 barrels (328 bpd) in 1960.

Peru has remained the only country on South America's Pacific Coast where oil production has been achieved from the Continental Shelf.

Amazon Basin. In the Amazon Basin, Ganso Azul recovered an output of 835,569 barrels or 2,283 bpd, an increase of about 4% from the previous year. Bulk of production is shipped to the Manaos refinery in Brazil and the balance to the national refinery in Iquitos, according to the local demand.

The Oriente Co., operated by the German companies Deutsche Erdoel, Elwerath and Wintershall, which started production at the end of 1959 from the Maquia field, produced in 1960 a total of 178,951 barrels or 489 bpd. For increasing its output, estimated to have a potential of 1,500-2,000 bpd, and for improving shipping facilities, the company has acquired three more barges of 8,000 barrels capacity each in the United States. They will augment its fleet to five barges with a total capacity of 40,000 barrels. The crude is shipped to Manaos and Iquitos.

Drilling. Drilling activity in Peru rose sharply in 1960, and well completions were more than doubled. During the year 150 wells were completed, of which 125 yielded oil and 25 were dry.

International completed 36 wells in its Brea-Pariñas field, of which 28 yielded oil and eight were dry. Of these, 28 were development wells and eight for exploration, of which three yielded oil. Besides, eight wells were drilled for water injection.

In Lobitos fields, 46 wells were completed, 44 yielding oil and two being dry. They included 44 development wells, of which 42 were productive. Two exploration wells yielded oil.

Footage drilled in Brea-Pariñas totaled 175,382 feet, and that in Lobitos 255,009 feet. Seven rigs were active.

Empresa Fiscal completed 25 wells, of which 22 were producing. One well was exploratory, and it was dry. Average depth of development wells was 5,300 feet and of exploration wells 7,600 feet. Five wells were drilling at the end of the year. Empresa in 1961 spudded a wildcat in the nothernmost part of its concession, near the mouth of the Tumbes River and the Equadorian boundary. It was drilling in March at some 700 feet. Total footage of Empresa in 1960 amounted to 157,037 feet. Three rigs were active.

Belco Petroleum Corp. completed a total of 26 wells, of which 24 were producing. In the Mirador field 17 wells were drilled, of which 16 were

Crude Oil and Condensate Production, Producing Oil Wells, and Drilling in Peru in 1960

COMPANY	Production			Oil Wells Producing At End of Year			Wells Completed				Wells Drilling End of Year
	Year		1959						Total		
	Total Bbls.	Bbls. Daily	Bbls. Daily	Flowing	Artificial Lift	Total	Oil	Dry	Wells	Footage	
1960											
International Pet. Co.											
Brea-Parinas, Crude	8,083,274	22,085	22,531	137	1,088	1,225	28	8	36	175,382	1
Condensate	692,244	1,891	2,117	...	...	...	...	...	...	...	..
Lobitos fields, Crude	8,695,032	23,757	20,644	122	608	730	44	2	46	255,009	3
Condensate	210,021	574	599	...	...	...	...	...	...	...	..
Empresa Petrolera Fiscal	968,590	2,646	2,544	36	149	185	22	3	25	157,037	5
Ganso Azul Co.	835,569	2,283	2,203	3	11	14	...	...	...	...	..
Belco Pet. Corp., Mirador field and offshore wells	379,190	1,036	216	22	10	32	24	2	26	129,395	3
Peruvian Pacific Pet. Co. (Cities Service), offshore	35,830	98	76	1	....	1	3	8	11	26,155	..
Petrolera Amotape	64,970	178	199	3	9	12	4	2	6	20,895	..
Douglas Oil Co. of Calif. wells operated by Lobitos Co.	10,991	30	....	....	....	....	...	...	...	...	..
El Oriente Co., Maquia field	178,951	489	151	9	1	10	...	...	...	...	..
Peruvian Pacific abandoned concession on mainland	2,637	7	....	....	....	....	...	...	...	...	..
Total, Crude	19,255,034	52,609	48,564	333	1,876	2,209	125	25	150	767,873	12
Total, Condensate	902,265	2,465	2,716	...	...	...	...	...	...	...	..
1959											
Total, Crude	17,725,847	48,564	.....	312	2,592	2,904	56	9	65	284,200	11
Total, Condensate	991,249	2,716	.....	...	...	...	...	...	...	...	..

producers. Besides, seven offshore wells, directionally drilled from land and all producers, were completed, and two wells were drilled in deeper waters.

Petrolera Amotape completed six wells to the Verdun sands, of which four yielded oil. But drilling was suspended at the end of the year.

Exploration in the Amazon Basin. Mobil Oil Co. of Peru, in association with the German companies, which defray 50% of the cost, and El Oriente Co., which is owner of the concession, on January 1, 1961, spudded its first well in Peru, Zorrillos 1. It was on the Aguaytia structure, at the mouth of the San Alejandro River, west of Pucallpa and about 40 miles northwest of Ganso Azul. An airstrip was constructed and a 7½-mile road was built for the second location, Aguaytia 1. Drilling equipment was shipped via the Amazon and Ucayali rivers, and Loffland Bros. carried out drilling as contractors. At the end of April 1961, Zorrillos 1 had been abandoned at 8,883 feet. It only had oil shows in the Cretaceous Agua Caliente sandstone. The rig was then moved to the second location, Aguaytia 1, about 6 miles to the northwest. In early May that well was drilling below 1,219 feet.

Cerro de Pasco Petroleum Corp., the oil subsidiary of the well known mining company, after several years of geological and seismic surveys, with Ross Cabeen & Co. as consultants, spudded its first wildcat on Jan. 22, 1961, on the Iscozazin structure, in the region of the Palcazu River in the southern Ucayali Basin. At the end of May, the well was drilling below 9,120 feet.

Other companies, including Gulf Oil, International Petroleum, Peruvian Pacific and Belco Petroleum Corp., continued geological surveys in the Amazon Basin.

Refining. Peru's refining capacity will be enlarged to around 60,000 bpd by the new 12,000-bpd refinery at Conchan, south of Lima, to be constructed at a cost of $15 million. It will be financed by the national Prado banking interests and the Bank of America. Standard Oil of California is in charge of putting it in operation. Fluor Corp. of Los Angeles is carrying out the engineering and supplying the equipment.

Photo courtesy Socony Mobil Oil Co., Inc.

Worker regulates flow from a Mobil de Venezuela well in eastern Venezuela.

Venezuela... crude oil production rises to record level. Use of natural gas increases

VENEZUELA'S OIL INDUSTRY continued to stress production and conservation in mid-1961, with operations proceeding in a stabilized manner. Some of the operating companies boosted their crude outputs last year, and others suffered declines (Table 1). In mid-1961, the situation continued more or less status quo. Industry eyed the government's course and direction. The government in turn tried to maintain a middle-of-the-road approach between extremists on both left and right.

No tax or other accounting adjustments in favor of the oil industry had been adopted by the Betancourt government by early 1961, despite hints that some relief was in sight. A new pay-as-you-go income tax was effected in February 1961 applying to extractive industries. The oil companies felt that the law, for which regulations were forthcoming, was discriminatory since it did not apply to all industries. The government felt that the oil and iron-mining industries are the main established tax revenue sources as practical matter, and that other types of enterprises must be stimulated to diversify Venezuela's development.

Concessions. Government sources indicate that no new concessions are to be granted in the future, though Argentine-type operating contracts might be entered into if needed.

By the end of 1960, all previous exploration concessions had been dropped or converted. There had been more than 500,000 acres of exploration concessions at the start of the year. Exploitation concessions at the end of 1960 amounted to 11,659,278 acres, a decline of more than 15 percent from the area covered by such grants as of a year earlier.

Among various changes last year, S. A. Petrolera Las Mercedes transferred part of its concessions to Coro Petroleum Co. and Caracas Petroleum S. A. This evidently accounts for the severe drop in Mercedes' 1960 crude oil production compared to 1959, and attendant boosts in Caracas' and Coro's (Table 1).

Most of the acreage under concession at the end of December lay in Anzoategui and Zulia states (57.3 percent of total). The three leading oil producers, Creole Petroleum Corp., Compañía Shell de Venezuela (CSV) and Mene Grande Oil Co. held 53.3 percent of Venezuelan acreage under lease with the remainder under concession to 26 other companies.

About 25.7 percent of the acreage relinquished was in the Maracaibo district; in Apure, 13.7 percent, Falcon, 8.4, and Guarico and Maturin, about 29.9 and 16.5 percent respectively. Minor amounts elsewhere, including some offshore acreage were dropped too. CSV dropped some large blocks in the Maracaibo region.

Similar to many other parts of the Free World in which enormous blocks of acreage were acquired during the 1950's, Venezuela's prospective areas which have been leased in the past have reached a fairly mature state of evaluation.

Under the act passed by the Venezuelan Congress in July 1960, the right to exploit hydrocarbons was granted to Corporacion Venezolana del Petroleo, in various tracts. Included are some National Reserve areas in Lake Maracaibo. In 1961 the new government oil entity drilled some oil wells on some proven acreage in the Lake. The grants amount to 349,542,570 acres, including 332,940,464 acres in the Maracaibo district in Zulia and Trujillo, and the remainder in the eastern states of Anzoatequi and Guarico.

Exploration was essentially dormant in Venezuela in 1960, at least compared to more active previous years. The following were totals of party months worked last year: surface geology, 33; seismograph, 10; and structure drill, 44. Some aerial photographic and topographic coverage was provided.

Creole, Shell, Mene Grande, Richmond, Phillips, and Venezuelan Atlantic Refining Co. (VARCO) were the only firms listed in government statistics as partaking in this work last year. About the only newsworthy coverage mentioned was some continuous marine profiling ("sparker") work done in Lake Maracaibo and seismic velocity tests conducted in some wells there by CSV.

Drilling. A total of 456 wells were completed in 1960, including 443 intended to find oil, 1 for gas and 12 injection wells. The 444 non-service wells are detailed in Table 2 by Lahee classifications. The completion totals were 342 oil, 1 gas, 6 gas injection, 1 water injection, 5 other fluid injection, 98 dry holes, and 3 wells abandoned for other reasons (Table 2).

Total amount of hole drilled was 3,533,158 feet, most of it in Barcelona and Maracaibo districts, and almost none in Barinas (Table 3). Average depth per well completed last year in Venezuela was 7,748 feet. These figures compare with the following 1959 drilling statistics: completions, 707; footage, 6,091,314; average depth per finished hole, 8,615 feet. Severe cost-cutting in Venezuela may have resulted in emphasis on drilling to shallower production.

Drilling was expected to continue to decline in 1961, but at a more moderate rate indicative of leveling off. There were 215 completions during the first six months this year, and a total of 415 new wells were anticipated in 1961. There were 31 wells being drilled during the week ended June 28, compared to 44 wells being drilled last December 31.

Important discoveries continued to be made last year. In the central Lake Maracaibo area, Mene Grande completed well 3-y-3X for 3,716 barrels of 28.9° API gravity crude daily from the Oligo-Miocene at 8,450 feet. Phillips completed a well in the same general area for 2,688 bpd of 29.3° API gravity crude from the Eocene at 14,470 feet.

Among eastern Venezuelan discoveries last year was a 2,424 bpd well

TABLE 1—Crude Oil Production in Venezuela in 1960 and 1959, by Companies

(Source: Technical Office of Hydrocarbons, Venezuelan Government)

COMPANY	Total Barrels		Barrels Daily		Percent Diff.
	1960	1959	1960	1959	
Creole Petroleum Corporation	400,375,615	404,522,565	1,093,922	1,108,281	— 1.3
Compania Shell de Venezuela Ltd.	275,935,815	291,161,960	753,923	797,704	— 5.8
Mene Grande Oil Company	146,882,856	135,270,825	401,319	370,605	8.3
Mobil Oil Company de Venezuela	44,021,046	41,349,390	120,276	113,286	6.2
Venezuelan Sun Oil Company	29,904,288	16,035,180	81,706	43,932	86.0
Richmond Exploration Company	23,981,435	18,170,065	65,523	49,781	13.2
Texas Petroleum Company	20,660,408	20,401,675	56,449	55,895	1.0
Phillips Petroleum Company	19,682,841	10,617,485	53,778	29,089	84.9
Sinclair Venezuelan Oil Company	18,803,716	17,458,315	51,376	47,831	7.4
Superior Oil Company of Venezuela	14,966,850	5,873,580	40,893	16,092	154.1
San Jacinto Venezolano, C. A.	14,135,439	12,685,575	38,621	34,755	11.1
Venezuelan Atlantic Refining Co.	9,975,264	9,440,725	27,255	25,865	5.4
Signal Oil and Gas of Venezuela	9,520,147	9,014,040	26,011	24,696	5.3
S. A. Petrolera Las Mercedes	6,029,748	11,659,195	16,475	31,943	— 93.9
Caracas Petroleum Company	3,304,843	11,680	9,030	32	28,118.8
Coro Petroleum Company	3,036,778	2,920	8,297	8	103,612.5
Talon Petroleum Company	392,584	464,280	1,073	1,272	— 18.5
Continental Oil Co. of Venezuela	65,458	1,825	180	5	3,500.0
Colon Oil Company, Ltd.	.....[1]	7,278,100	.....[1]	19,940	.....[1]
Total, Venezuela	1,041,675,131	1,011,419,380	2,846,107	2,771,012	2.7

[1] Colon was sold to Compania Shell de Venezuela in December 1959.

OIL FIELDS, PIPE LINES AND REFINERIES OF VENEZUELA

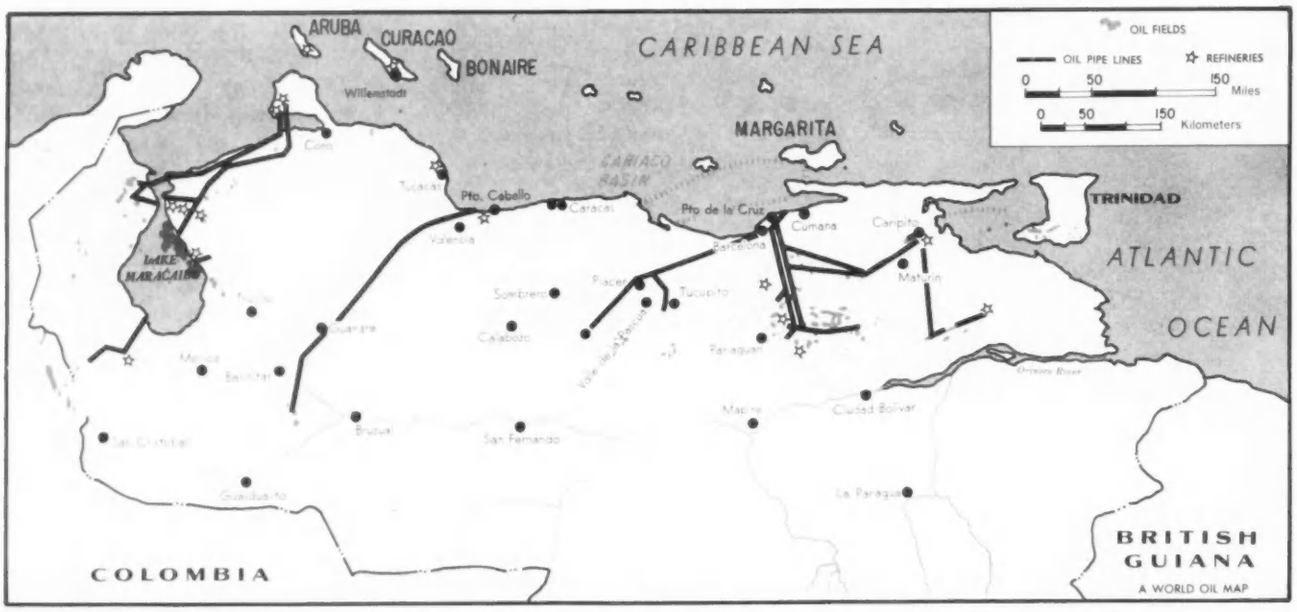


TABLE 2—Drilling Activity in Venezuela in 1960, by Companies and Districts

(Source: Technical Office of Hydrocarbons, Venezuelan Government)

Company and District	Wells Completed							Productive Wells							Dry Holes							Wells at Yr. End	
	0	1	2a	2b	2c	3	Total	0	1	2a	2b	2c	3	Total	0	1	2a	2b	2c	3	Total	Suspended	Drilling
BY COMPANIES																							
Creole, Total	44	45	..	8	6	4	107	50	10	..	1	17	1	79	..	20	..	..	5	3	28	2	7
Maracaibo	43	10	..	8	6	1	68	50	4	..	1	1	..	56	..	6	..	..	5	1	12	2	6
Barcelona	1	35	..	..	..	1	37	..	6	..	..	16	..	22	..	14	..	..	..	1	15	..	..
Maturin	..	..	..	..	..	2	2	..	..	..	..	..	1	1	..	..	..	..	..	1	1	..	1
Shell, Maracaibo	35	18	..	2	1	2	58	37	13	..	1	2	..	53	1	2	..	..	..	2	5	8	8
Mene Grande, Total	25	94	..	4	1	8	132	7	36	2	..	46	4	95	2	29	..	2	..	4	37	3	11
Maracaibo	..	8	..	3	1	5	17	..	5	1	..	3	2	11	..	2	..	1	..	3	6	3	2
Barcelona	25	85	..	1	..	3	114	7	31	1	..	43	2	84	2	26	..	1	..	1	30	..	9
Maturin	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..
Mobil, Total	28	10	..	..	..	3	41	27	4	..	..	..	1	32	1	6	..	..	..	2	9	1	3
Barcelona	28	10	..	..	..	2	40	27	4	..	..	..	1	32	1	6	..	..	..	1	8	..	1
Maturin	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..
Barinas	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	2
Texas, Total	11	14	..	..	3	1	29	11	14	..	..	1	..	26	..	..	..	..	2	1	3	..	5
Barcelona	10	14	..	..	1	..	25	10	14	..	..	1	..	25	..	..	..	..	..	..	..	..	5
Maturin	1	..	..	..	2	1	4	1	..	..	..	..	..	1	..	..	..	..	2	1	3	..	..
Varco, Total	7	2	..	..	..	1	10	7	2	..	..	..	..	9	..	..	..	..	..	1	1	..	..
Maturin	7	2	..	..	..	..	9	7	2	..	..	..	..	9	..	..	..	..	..	..	..	..	..
Barinas	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..
Richmond, Maracaibo	..	1	..	..	..	2	3	..	..	..	..	..	1	1	..	1	..	..	..	1	2	1	1
Signal, Maracaibo	1	2	..	..	..	..	3	..	1	1	..	1	..	3	..	..	..	..	..	..	..	3	..
Sun, Maracaibo	5	9	..	..	2	..	16	5	6	..	..	4	..	15	..	..	..	..	1	..	1	..	1
S. Jacinto, Maracaibo	..	2	..	..	1	..	3	..	1	..	..	..	..	1	..	1	..	..	1	..	2	..	..
Phillips, Total	5	6	..	..	1	3	15	5	6	..	..	1	2	14	..	..	..	..	..	1	1	19	2
Maracaibo	..	..	..	..	..	2	2	..	..	..	..	..	1	1	..	..	..	..	..	1	1	..	..
Barcelona	..	..	..	..	..	1	1	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..
Maturin	5	6	..	..	1	..	12	5	6	..	..	1	..	12	..	..	..	..	..	..	..	19	2
Talon, Maracaibo	1	..	..	..	..	..	1	1	..	..	..	..	..	1	..	..	..	..	..	..	..	1	1
Sinclair, Total	4	2	..	1	..	1	8	4	1	..	..	..	..	5	..	1	..	..	..	1	3	1	1
Barcelona	..	..	..	1	..	1	2	..	..	..	..	..	..	..	..	..	..	..	..	1	2	..	..
Maturin	4	2	..	..	..	..	6	4	1	..	..	..	..	5	..	1	..	..	..	..	1	..	..
Barinas	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Petmer, Barcelona	..	2	..	..	..	..	2	1	..	..	..	..	..	1	..	1	..	..	..	..	1	..	3
Continental, Maturin	..	6	..	..	6	..	12	..	6	..	..	1	..	7	..	..	..	..	5	..	5	..	1
Coro, Maturin	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..
Caracas, Maturin	2	..	..	..	..	..	2	1	..	..	..	..	..	1	1	..	..	..	..	..	1	..	..
Pan American, Maturin	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..
BY DISTRICTS																							
Maracaibo	85	50	..	13	11	12	171	93	30	2	2	11	4	142	1	12	..	1	7	8	29	18	19
Barcelona	64	146	..	2	1	8	221	45	55	1	..	60	4	165	3	47	..	2	..	4	56	..	18
Maturin	19	18	..	..	9	5	51	18	15	..	..	2	1	36	1	3	..	..	7	4	15	19	4
Barinas	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	2	3
Total	168	214	..	15	21	26	444	156	100	3	2	73	9	343	5	62	..	3	14	17	101	39	44

0: Development well; drilled at inside location to proven zone. 1: Extension well; drilled outside of proven zone to extend it. 2a: Shallow "vertical wildcat"; drilled inside proven area in search of shallower pay zone(s)' than proven one(s). 2b: Deep "vertical wildcat"; drilled inside proven area in search of deeper pay zone(s). 2c: "On trend" wildcat; drilled outside of proven areas but where known subsurface conditions indicate likelihood of production.
3: New field wildcat; drilled in new areas where the existence of hydrocarbons is unknown.

completed by Creole in the Greater Oficina area, Acema 1. Productive zone was at 12,688 feet.

In Lake Maracaibo, Mene Grande completed some prolific new oil production in the Ceuta area. Venezuelan Sun continued to develop big oil reserves in the central part of the Lake. Sun's SVS-41 penetrated 1,797

TABLE 3—Footage drilled in Venezuela in 1960, by Districts and Categories

DISTRICT	Exploitation	Semi-Exploratory	Exploratory	Injection	Total
Maracaibo	546,115	453,869	368,037	10,065	1,378,086
Barcelona	351,987	851,925	554,872	42,349	1,801,133
Maturin	102,843	148,906	94,818	.....	346,567
Barinas	.....	.....	7,372	.....	7,372
Total	1,000,945	1,454,700	1,025,099	52,414	3,533,158

feet of net pay sand, a record for Venezuela. Sun's SLGX-12-7, located on block 12 became the deepest producing well in the country, with the lower zone at 15,400-15,902 being tapped.

Production. Crude oil production in Venezuela in 1960 amounted to more than a billion barrels. This was the third year in history when oil production in barrels reached 10 digits, previous billion-barrel years being 1957 and 1959. The 1960 yield was 2.7 percent higher than 1959's (Table 1).

Crude oil production this year during the first six months was running slightly ahead of output during the same period in 1960. The average as of July 5, 1961 was 2,910,643 bpd, compared to 2,849,517 bpd from January 1 to July 5, 1960.

Oil output last year is detailed by companies in Table 1. No strong changes were noted in the relative positions of the four most prolific producers (Creole, Shell, Mene Grande, and Mobil). Some of the others have shifted places in relative outputs depending on marketability of their crude and some other factors already mentioned. Phillips, Sun, and Superior have strongly boosted outputs in Lake Maracaibo.

Considered by API gravity, production of crudes higher than 24.9° API gravity declined very slightly in 1960 compared to 1959, while production of the heavier crudes was boosted significantly.

By areas, about 72.6 percent of the 1960 yield was from the Maracaibo district, 25.1 percent from eastern Venezuela, 2.2 percent from Barinas-Apure, and 0.1 percent from Falcon.

In Maracaibo, the Bolivar Coastal fields continue to dominate production, having yielded 87.6 percent of the district's, and 63.6 percent of the nation's crude oil output in 1960. In eastern Venezuela, the Oficina area provided 70 percent of the district's and 17.8 percent of the nation's output. The most productive fields in the east were Quiriquire, Anaco (Guarico sub-district), Jusepin, Anaco (Maturin sub-district), and Temblador.

In Barinas, production by Sinclair Venezuelan is holding up well; fears that the precariously low surface pressures (about 100 psi) would rapidly dwindle have proven unfounded. When El Palito refinery was shut down at turnaround, wells in Sinco and Silvan fields were also shut in for bottom hole pressure tests which indicated no decline despite the prolonged production period. An excellent water drive is evident at Sinco and Silvan. This may not be true of San Silvestre field, since sizable faults cut the pay zone there and may impair a water drive.

In the Gulf of Paria, Posa field has proven to be disappointing. Seven productive wells have been drilled directionally from a platform at the discovery site. Further development of this field (by Paria Operations, Inc.) has been suspended.

A total of 2,247,339 barrels of natural gasoline (6,140 daily) and 3,309,089 barrels of LPG (9,041 daily) not mixed with crude and thereby not losing identity were also produced in Venezuela last year.

Reserves. Crude oil reserves in Venezuela at the end of 1960 were put at 17,353,558,200 barrels. This was more than the 16,875,533,000 barrels calculated at the end of 1959, and an encouraging increase considering the record crude oil production last year. Reserves of natural gas liquids as of December 31, 1960 were put at 106,926,600 barrels, augmenting crude oil supplies.

Almost all the newly-discovered reserves last year were in the center of Lake Maracaibo. Extensions in the same area also were highly instrumental in maintenance of a satisfactory reserve level.

Natural gas reserves at the end of 1960 were put at 33,642,164 MMcf, slightly above the 33,399,726 MMcf figure as of a year earlier. Most of the gas is associated with crude oil. Non-associated gas reserves at the end of December were put at 3,083,269 MMcf.

Pipe lines. New construction in 1960 consisted mainly of relatively short loops to augment existing facilities. However, in mid-1961 Phillips was reported finishing a 45-mile crude line from Morichal field in Monagas to a new deep-water terminal near Puerto Ordaz on the Orinoco River. Phillips' 1960 annual report states that 13 of the company's Venezuelan wells were drilled on its 56 percent interest lot 9 in southern Monagas where a large low-gravity crude oil reserve has been established.

Natural gas. Natural gas production in 1960 decreased last year from 1959. Last year's yield was 1,114,612 MMcf for an average of 3,045 MMcfd. More strict control of gas-oil ratios in producing oil wells was responsible for reduced gas output. Average natural gas production in 1959 was 3,080 MMcfd, and in 1958, 3,049 MMcfd. The following is the breakdown in 1960 as to disposition of natural gas produced:

- 390,690 MMcf (1,067 MMcf daily), 35.1 percent, injected to maintain pressure in oil reservoirs
- 67,169 MMcf (183 MMcfd), 6.0 percent, used as fuel subject to tax
- 35,951 MMcf (98 MMcfd), 3.2 percent, used as fuel not subject to tax
- 24,155 MMcf (66 MMcfd), 2.2 percent, sold subject to tax
- 35,386 MMcf (97 MMcfd), 3.2 percent, sold not subject to tax
- 17,198 MMcf (47 MMcfd), 1.5 percent, transformed to natural gasoline and LPG
- 544,063 MMcf (1,487 MMcfd), 48.8 percent, flared. Although nonutilized natural gas in Venezuela was the energy equivalent of about 257,000 barrels of crude oil daily, it was clear that conservation and use of gas is increasing. In 1958, flared gas amounted to 56.3 percent of the total, and in 1959, 54.5 percent. Construction of various plants to use and/or conserve gas continued last year. At the end of December there were 43 gas injection plants with an aggregate capacity of 1,765,750 Mcfd. Five new injection plants were being built.

TABLE 1—Drilling and Crude Oil Production in Austria, 1960 and 1959

ITEM	1960	1959
DRILLING		
Wells Completed	94	82
Oil	62	63
Gas	12	4
Dry	20	15
Footage Drilled, Feet	492,522	356,185
Average Depth	5,240	4,344
Wells Drilling, Year End	13	.....
PRODUCTION		
Crude Oil Production, Thousand Barrels	16,620	16,690
Barrels Daily	45,409	45,727
Percent Change	—0.7	—14.6
Producing Oil Wells	913	.....
Reserves, Year End, Million Bbls.	254	267

WESTERN EUROPE

Austria... Western firms receive indemnity for World War II losses. Oil production decline is arrested

SIGNIFICANT PROGRESS has been made toward complete fulfillment of the 1955 Vienna Memorandum, wherein the Austrian government agreed to indemnify British, French and U.S. companies for losses suffered during the country's occupation (1938-1945).

In July 1960 an agreement was signed with the oil firms which stipulated that Austria will pay RAG (Shell/Vacuum) $13.7 million in six annual installments. Half of this amount will be paid to the Crude Utilization Company (state company OeMV, 74 percent; Mobil, 13 percent; Shell, 13 percent) for construction of the 36,000 barrels per day Schwechat refinery, which was put on stream early in 1960.

The remaining $6.85 million will be given to the companies for reinvestment in Austria. The government also agreed to give Shell and Mobil its $600,000 interest in the Austrian Mineral Oil Works Company, and RAG received new concessions at Wels and Pettenbach in Upper Austria.

"I'll take yours and you take mine." Last year, Austria shipped 6.8 million barrels of crude oil (41 percent of total production) on the basis of the 1955 State Treaty. In return, Russia delivered 3.6 million barrels of crude, leaving Austria 13.4 million barrels—not enough to meet demand.

This swap-out arrangement began in January 1959. At that time, Khruschev agreed to cut Austria's 49 million barrel crude oil indemnity payment in half on one condition: Austria was to continue its deliveries as usual, while Russia shipped Austria 24.5 million barrels of crude in yearly installments of 3.5 million barrels.

It is believed that these Soviet crude deliveries are to set the stage for further purchases, and that Austria may thus be induced to adjust its refineries to the processing of sulfur-rich Soviet crude.

Production decline levels off. After dropping 11.0 percent in 1958 and 14.6 percent in 1959, Austria's crude oil production held its own during 1960. Production averaged 45,409 barrels daily, down only 0.7 percent from 1959.

At least part of this improvement is reflected in the fact that the steady decline of the Lower Austrian fields in recent years is now being offset by a significant increase in the Upper Austrian fields.

While crude oil production was down slightly last year, natural gas production increased 30.2 percent, to 51.9 billion cubic feet. This followed a 46 percent increase during 1959.

Reserves. Proved reserves in the Vienna Basin are now estimated to

TABLE 2—Crude Oil Production in Austria, by Companies

	Total Barrels				Barrels Daily			
*COMPANY	1960	1959	1958	1957	1960	1959	1958	1957
OeMV	15,290,104	15,521,910	18,330,060	20,726,484	41,776	42,528	50,219	56,785
EPG	†	†	224,190	248,498	†	†	614	681
RAG	1,329,574	1,168,316	798,872	790,506	3,633	3,199	2,189	2,166
Van Sickle			195,319	189,647			535	520
Total	16,619,678	16,690,226	19,548,441	21,955,135	45,409	45,727	53,557	60,152

* Abbreviations.—OeMV: Austrian Mineral Oil Administration, state company. EPG: Erdoel Produktions Gesellschaft, state company, 50% OeMV-owned prior to June 1959 and then merged with OeMV. RAG: Rohoelgewinnungs Gesellschaft, owned by Socony Mobil and Shell of U.S.A. Van Sickle: a Canadian company.

† In June 1959 EPG was merged with OeMV.

be 254 million barrels of crude oil, 351.3 billion cubic feet of wet gas, and 456 billion cubic feet of dry gas.

In the Matzen area, currently producing 82 percent of the total crude output, are stored 90 percent of the total oil reserves. The largest field is at Zwerndorf, two-fifths of it extending into Czechoslovak territory. Recoverable gas reserves are estimated to be 351.1 billion cubic feet. About 102.9 billion cubic feet of dry gas are believed to be stored in the Matzen area.

In Upper Austria province, crude oil reserves of RAG's Ried field are estimated at 6.8 million barrels.

Drilling declines. Approximately 56 productive wells will be completed in Austria during 1961, compared with 69 in 1960, and 82 in 1959.

State company OeMV produced 92 percent of the Austrian crude and 99 percent of the gas during 1960. Proved crude oil reserves in OeMV's concession areas, totaling 3,987 square miles, are estimated at 211.6 million barrels, of which 149.4 million barrels are to be produced between 1959 and 1969. Average yield of the 810 producing oil wells was 50.2 barrels per day.

In mid-1960, OeMV obtained four new concession areas (St. Corona, Hollabrunn, Laa/Thaya, St. Poelten.

Of OeMV's 39 drilling rigs, 13 were constantly operating throughout 1960. No major finds were reported. However, last November Aderklaa No. 80 discovered oil for the first time in the Alpine lime zone of the Vienna Basin.

OeMV has earmarked $4.6 million for drilling this year, with footage totaling 538,100 feet, compared with 587,300 feet in 1960.

RAG (Shell/Vacuum) produces annually 746,680 barrels of crude from its Geiselberg and Zistersdorf fields in the Vienna Basin. Output in the Upper Austrian concession increased from 128,327 barrels in 1959 to 420,584 barrels last year.

At least 2 of RAG's 4 drilling rigs were in operation throughout 1960.

Demand outpaces supply. Domestic crude production and the range of refinery products does not cover Austria's demand. Product imports totaled 8.3 million barrels in 1960, compared with 6.9 million barrels in 1959.

Russian satellite countries supplied 50.4 percent of Austria's needs, or 4.2 million barrels last year, compared with 50.1 percent or 3.4 million barrels in 1959. Austria exported 1.1 million barrels of oil products in 1960, compared with 1.3 million barrels in 1959. The most important export item was gas oil which went almost exclusively to West Germany.

Belgium... exploration is now underway

Oil and gas exploration was finally getting under way in Belgium in 1960 and 1961. Bataafse Petroleum Mij (BPM) applied last year for permission to prospect in a 1,000-square-mile area in the Dinant Basin near Namur in the southern part of the country. Belgian Shell Co. SA did 1½ party months of gravity surveys in this area last year. The license was reported granted early in 1961. About a year's follow-up seismic work is expected before drilling might commence during the latter part of 1962.

A permit applied for by Societe Campinoise de Recherches et d'Exploitations Minieres (SCREM) was reported granted in December 1960. This 1,467-square-mile permit is in Anvers and Limbourg provinces in the northeast, near southern Holland. A group of Belgian interests are involved in this venture. Petrofina is the operator.

Some additional permits were reportedly requested. Belgium's subsurface geology has become better known in recent years. Considerable core drilling has been done to evaluate coal deposits and for other research purposes not directly connected with oil and natural gas.

Denmark... trend is eyed from West Germany

Deutsche Erdol A G reportedly requested an exploration concession in southern Jutland in 1960, but results of such an application were not announced by mid-1961.

Three current refinery projects enhance the potential market for any crude oil to be found in Denmark. Dansk Veedol A/S (Tidewater Oil Co. affiliate) is building a 20,000-bpd refinery at Kalundborg, 60 miles west of Copenhagen. It is slated to enter operation this year. Gulf Oil Corp. has a 30,000 bpd plant underway at Stigsnaes in Southwest Zealand, projected to go on stream by the end of 1962. The Shell group also was said to be considering building a Danish refinery.

Eire... first wildcat to be drilled in 1961

Exploration in Eire was proceeding rapidly in 1961 following passage of the Petroleum and Other Minerals Development Law, which took effect early in 1960. Ambassador Irish Oil Ltd., fully-owned subsidiary of Ambassador Oil Corp. of Fort Worth, expected to drill the first test well for oil and gas in the Irish Republic late this year. On April 5, 1961, The Ohio Oil Co. announced that, together with Continental Oil Co., it would join Ambassador in the Irish Oil search. Ambassador will remain the operator. Participation of Ohio and Continental is subject to approval by the government.

Ambassador Irish has an exclusive exploration license on all of Eire's 20 million acres, including offshore areas. All but the extreme northwest and southeast coastal areas are considered to have oil and gas possibilities. There are several sedimentary basins in central Ireland, ranging in thickness from 3,500 to 8,500 feet. Five more or less distinct structural basins are the Northwest, Central, Southwest and Southeast Basins and Kingscourt Graben. Hydrocarbons

have been found in certain outcrops, and a gas blowout was reported in a core hole.

Paleozoic strata similar to the English section, largely composed of carbonates, are being mapped on the surface and investigated by seismic work. Average drilling depths will be from 2,000 to 6,000 feet. Ambassador must drill a 5,000-foot well and spend at least $300,000 on exploration by 1963, according to its agreement with the government. Minimum royalty of 7½ percent of market value of oil and gas produced must be paid. The agreement also provides for a depletion provision.

France... Paris Basin fields boost nation's crude oil production to 40,000 bpd in 1961. Drilling is active

Drilling continued at a vigorous pace in metropolitan France in 1960 and early 1961, as emphasis on Paris Basin production continued to draw rigs into this shallow and moderate depth area. Four of the 6 most recent discoveries were in the Paris Basin.

Crude oil production amounted to 14,116,246 barrels in 1960, an average of 38,569 bpd (Table 1). This was 6,479 bpd or 20.2 percent higher than the 32,090 bpd rate of 1959. Both main producing provinces, the Aquitaine and Paris basins, boosted 1960 yields despite a slight decline last year in Parentis field production. France's crude oil output continued at about 40,000 bpd during the first half of 1961.

Natural gas production continued to increase strongly. The total yield of raw natural gas not associated with oil was 155,598 MMcf (425 MMcf daily). Most of this offtake (145,180 MMcf, or an average of 397 MMcfd) was from the deep Lacq field in southern France, with the remaining 10,418 MMcf (28 MMcfd) being coaxed from the older St. Marcet gas field near the Pyrenees Mountains by Regie Autonome des Petroles (RAP). Minor quantities of natural gasoline, propane and butane are also produced at St. Marcet.

At Lacq, SNPA's 1960 production also included 790,500 metric tons of sulfur, according to *Petrole Informations*. The 1960 gas yield at Lacq was almost double the 217 MMcf daily output in 1959.

Gas production in France continued to rise in 1961. It was averaging about 620 million cubic feet daily in June.

Drilling activity last year is reflected by the 71 development wells completed in the Paris Basin (Table 1) compared to only 18 exploitation tests in Aquitaine. Including wildcats, there were 212 wells completed in France in 1960. Of the total, 73 were oil wells, 8 were gas completions, and there were 131 dry holes. In addition, considerable structure and stratigraphic drilling was done last year.

TABLE 1—Crude Oil Production and Development Drilling in France in 1960

BASIN Company, Field	Crude Oil Production, Bbls. Year Total	Year Daily	[2]Cumulative to End 1960	Wells Completed Oil	Dry	Total	Footage	Wells Drilling Yr. End
AQUITAINE BASIN	**10,280,119**	**28,088**	**64,002,322**	**12**	**6**	**18**	**136,663**	**3**
ESSO REP. Total	**9,610,307**	**26,258**	**49,259,558**	**9**	**6**	**15**	**129,809**	**2**
Parentis	8,101,386	22,135	45,877,833	..	...	...	.....	..
Mothes	475,075	1,298	1,392,105	..	...	...	.....	..
Lugos	192,156	525	863,255	..	...	...	.....	..
Cazaux	770,098	2,104	824,059	8	3	11	99,361	2
Lucats	23,694	65	54,408	..	1	1	7,540	..
Mimizan-Nord	47,898	131	47,898	1	2	3	22,908	..
SNPA, Lacq up. Zone	**669,812**	**1,830**	**14,742,764**	**3**	...	**3**	**6,854**	**1**
PARIS BASIN	**3,345,295**	**9,140**	**5,064,450**	**59**	**12**	**71**	**322,873**	**2**
Petrorep, Coulommes	**1,172,214**	**3,203**	**2,386,584**	**2**	...	**2**	**12,618**	..
CEP-RAP, Chailly Chartrettes	**777,890**	**2,125**	**1,022,565**	**27**	**4**	**31**	**175,769**	**1**
COPESEP, Total	**958,414**	**2,619**	**1,101,414**	**6**	...	...	**29,233**	..
St. Martin de Bossenay	956,420	2,613	1,099,420	5	...	5	24,066	..
Avon-la-Peze	1,994	6	1,994	1	1	2	5,167	..
RAP, Total	**260,198**	**711**	**260,198**	**11**	**2**	**13**	**68,464**	**1**
Villemer	257,122	703	257,122	10	2	12	62,601	1
Valence-en-Brie	3,076	8	3,076	1	...	1	5,863	..
CEP-FROPEX, Chateaurenard	**155,728**	**425**	**272,838**	**10**	**2**	**12**	**24,453**	..
CEP, St. Firmin des Bois	**20,851**	**57**	**20,851**	**3**	**3**	**6**	**12,336**	..
RHINE GRABEN								
ALSACE	**490,832**	**1,341**	**24,590,375**	**1**	...	**1**	**1,903**	..
PREPA, Total	**333,532**	**911**	**1,611,770**	**1**	...	**1**	**1,903**	..
Scheibenhard	206,800	565	776,837	..	...	...	.....	..
Donau	22,826	62	225,170	1	...	1	1,903	..
Eschau	45,784	125	173,735	..	...	...	.....	..
Staffelfelden	58,122	159	436,028	..	...	...	.....	..
PECHELBRONN, Pechelbronn	**157,300**	**430**	**22,978,605**	..	...	...	.....	..
Total, France	**14,116,246**	**38,569**	**93,657,147**	**72**	**18**	**90**	**461,439**	**5**
Total, 1959[4]	11,712,828	32,090	.....	59	129	201[3]	1,418,783	32

[1] Abbreviations of names of firms used in Table 1 and not named in full in Table 2 are written as follows: SNPA; Societe Nationale des Petroles d'Aquitaine. PETROREP; Societe Petroliere de Recherches dans la Region Parisienne. CEP; Compagnie d'Exploration Petroliere. FROPEX; France-Outremer de Prospections et d'Exploitations Petrolieres (SAF). PREPA; Societe de Prospection et Exploitations Petrolieres en Alsace. PECHELBRONN; Pechelbronn Societe Anonyme d'Exploitations Minieres.

[2] Cumulative production figures are from French sources, applying only to fields reported on production during 1960. May not be exactly in accord with cumulative **World Oil** production figures.

[3] Includes 13 gas wells.

[4] 1959 drilling figures include wildcats.

TABLE 2—Recent Oil and Gas Discoveries in France, Through May 1, 1961

Field or Well Name and OPERATOR[7]	Completion Date of Discovery	Oil or Gas	Exploration Method	Type Trap	Reservoir Depth, Feet	Reservoir Lithology	Reservoir Age	Wells Prod.	Wells Dry	Wells Dril.	Prod. Bbls. Daily	Remarks
Aquitaine Basin												
Mimizan-Nord, ESSO-REP	Dec. 1959	oil	seis, ss[1]	f.a.[2]	4,757	r.l.[4]	Albian	1	2	..	170	On pump
Charlas, R A P	Oct. 1959	gas	seis, ss	f.a.	7,054	ss–ls[5]	Senonian, Cenomanian	1	..	..	...[6]	High pressure
Paris Basin												
Avon-la-Peze 1, COPESEP	May 1960	oil	seis, ss	f.a.	5,101	limestone	Dogger	1	1	..	...	Small producer
Gisy-les-Nobles 1, COPESEP	Aug. 1960	oil	seis, ss	f.a.	4,790	limestone	Dogger	1	1	..	76	.....
Les Marchais 1, COPESEP	Dec. 1960	oil	seis, ss	anti.[3]	4,409	limestone	Dogger	1	..	..	...	Small producer
Valence-en-Brie 101, R A P	Nov. 1960	oil	seis, ss	anti.	5,758	limestone	Dogger	2	2	1	100	.....

[1] Seismic and subsurface. [2] Faulted anticline. [3] Anticline. [4] Reef limestone. [5] Sandstone—limestone. [6] Gas only. IP 4.3 MMcfd. [7] Abbreviations of names of firms used in Table 2 are written in full as follows: ESSO REP; Societe Esso de Recherches et d'Exploitation Petrolieres. RAP; Regie Autonome des Petroles. COPESEP; Compagnie des Petroles du Sud-Est Parisien.

SNPA completed 25 injection wells at Lussagnet in connection with a gas storage project, and also drilled 10 stratigraphic holes on the Montelimar permit in the Rhone Valley.

Total amount of hole drilled in 1960 was 1,272,426 feet, less than the 1,418,783 feet in 1959 and 1,499,155 feet in 1958. Again a shift to the shallower Paris Basin is stressed. Drilling continued in 1961 at a similar pace to that of 1960, with about 30 rigs working at midyear.

Exploration. No outstanding discoveries were made last year. The most recent finds (Table 1) lack the promise of offsetting water encroachment in producing fields in the Paris Basin.

Although most Paris Basin exploration has been directed at the Dogger (Jurassic) horizon, shallow Neocomian sands which produce at Chateaurenard have also been found to be oil-bearing at St. Fermin des Bois. As of May 1, 1961, this new field had 9 oil producers and 3 dry holes.

Although seismic work is becoming more effective in the Paris Basin, and it is now sometimes possible to follow Dogger-level horizons in seismic data, deep structure-drilling is sometimes used by some companies.

In the Aquitaine Basin, the deep (11,000-16,000 feet) Lacq field has been drilled up. ESSO REP continues wildcatting in southwestern France and also expected to drill in the Languedoc Basin this year.

Cazeaux field, located in the Aquitaine Basin about 20 miles north of Parentis field on the Atlantic Coast, is proving to be fairly important, although it is much smaller than Parentis. In April 1961 it was producing about 3,100 bpd, and was expected to boost its yield to 3,500 or 4,000 bpd by the end of December. A number of sandstone lenses at or near the Albian-Aptian contact are oil-productive. These sands are very lenticular, indicating deltaic deposition. Of the first 16 wells completed, 12 were oil producers and 4 were dry holes. Reserves as of early 1961 were tentatively put at from 30 to 50 million barrels.

West Germany... reserves are increased despite a tapering off in drilling activity

THREE NEW OIL FIELDS and one new gas field were discovered in West Germany in 1960, a year in which the center of exploration activities was the Weser-Ems district. This district is the link between the Emsland producing area and the older oil producing district of Hanover.

Significant in the country's oil industry developments is the shift by a number of German oil companies to foreign exploration. One result, of course, has been to reduce drilling operations in the Federal Republic.

The nation's domestic petroleum demand is continuing to rise. In 1960, demand increased 25.6 percent, far exceeding the world demand increase level. This rapid rise has led to the need for imports of both crude oil and products.

Last year, domestic crude supplied only 18.3% of the nation's requirements, as compared with 21.5% in 1959.

Drilling. Total footage drilled during 1960 amounted to 2,090,751 feet, or about 380,000 feet less than in 1959. Of the 376 development wells completed last year, 303 found oil, 10 discovered natural gas, and 63 were dry. Of the 75 exploratory tests completed, 9 found oil, 3 reported natural gas, and 63 were dry holes.

At the end of 1960, 80 wells were being drilled, 25 fewer than as of a year earlier.

Production. In 1960, and for the first time, Western Germany daily average crude production amounted to more than 100,000 barrels. Daily average output of 107,274 barrels, as compared with 99,259 barrels in 1959, resulted in an annual production of 39,262,169 barrels. In 1959, crude production totaled 36,229,582 barrels.

A future steady increase in production can be expected, principally in the northern producing areas. However, this development will be tempered in 1964 because at that time domestic crude oil will lose the protection of the current import duty.

In fact, after 1964, numerous stripper wells may be abandoned. As of Jan. 1, 1961, a total of 3,881 oil wells were producing compared with 3,745 oil wells on Jan. 1, 1960.

Natural gas production rose 15.6% in 1960 with an output of 15.8 billion cubic feet, 2.1 billion cubic feet more than in the preceding year.

A new gas pipe line was being laid from the Emsland fields to Dorsten,

Crude Oil and Natural Gas Production, Producing Wells, and Drilling in West Germany in 1960, by Regions

REGION	CRUDE OIL Production Total Barrels	CRUDE OIL Production Bbls. Daily	CRUDE OIL Producing Wells End 1960	NATURAL GAS Production Thous. Cu. Ft. Total	NATURAL GAS Production Thous. Cu. Ft. Daily	NATURAL GAS Producing Wells End 1960	Total Footage Drilled in 1960 (Feet)	WELLS COMPLETED IN 1960 Field and Extension Wells Oil	Gas	Dry	Total	Wildcats Oil	Gas	Dry	Total	All Wells Oil	Gas	Dry	Total	Wells Drilling at End of 1960
Schleswig-Holstein-Hamburg	3,493,030	9,544	301	.....	.....	....	177,072	20	..	1	21	1	..	3	4	21	..	4	25	5
Emsland	9,629,325	26,310	1,102	4,171,019	11,396	9	349,617	87	3	3	93	1	1	3	5	88	4	6	98	14
Weser-Ems	9,450,029	25,820	735	4,591,798	12,546	6	668,333	116	..	10	126	1	1	10	12	117	1	20	138	32
Hanover	14,185,601	38,758	1,504	571,149	1,560	6	475,063	50	..	25	75	4	..	18	22	54	..	43	97	17
Upper Rhine Valley	1,512,186	4,132	193	2,831,274	7,736	59	171,557	20	3	17	40	..	..	10	10	20	3	27	50	1
Alpine Foreland	991,998	2,710	46	3,653,761	9,983	21	219,190	10	4	7	21	2	1	11	14	12	5	18	35	8
Others	.....	.....	.....	.....	.....	....	29,919	....	..	..	....	..	..	8	8	....	....	8	8	3
Total	39,262,169	107,274	3,881	15,819,001	43,221	101	2,090,751	303	10	63	376	9	3	63	75	312	13	126	451	80

on the northern edge of the Ruhr district, where natural gas is combined with coke gas for industry.

A marked increase in natural gas production is expected upon the completion of a new gas-burning power plant on the Weser River. At the beginning of 1961, natural gas producing wells numbered 101, only one less than on Jan. 1, 1960.

Reserves. German Geological Survey estimates of crude reserves reflect an increase from 1960. As of Jan. 1, 1961, the Survey estimated reserves at 624,700,000 barrels, up 106,900,000 barrels from the previous year estimate.

While new-field discoveries added approximately 30 million barrels of crude oil to reserves, the bulk of the estimated increase resulted from a more optimistic valuation of production rates of some fields in which secondary recovery methods are being applied successfully.

Of the 1961 estimate, 489,800,000 barrels were reported as proven, and 134,900,000 barrels were classified as probable.

Exploration. Although it is doubtful whether an offshore test will be drilled in the near future in the area, some geophysical work was being done in the offshore areas of the North Sea and Baltic Sea coasts.

Geophysical operations continued at a reduced rate last year as compared with 1959. Nearly 50 crews were reported in operation in the country during the year, as compared with 59 crews reported active in 1959.

Of the 451 wells completed in 1960, slightly more than 72% were successful. Sixteen percent of the completed wildcats found new oil or gas deposits as compared with 21% in 1959 and 15.4% in 1958.

New Discoveries. The four commercial discoveries reported last year included:

1. Gross-Hamburg 2, located south of Hamburg town. This joint venture of Gewerkschaft Elwerath—Mobil Oil—Preussag found oil in the Dogger formation at a depth of about 7,100 feet. A subsequent well was completed in April 1961, which boosted production from the field to more than 300 barrels of 29° API gravity crude daily. Structurally, the field belongs to the Dogger trough of Hamburg.

2. Meppen 1, located east of Hebelermeer oil field in the Emsland oil province. This joint venture of Deutsche Schachtbau-Gewerkschaft Elwerath-Mobile Oil-Wintershall found oil in the Serpulite and the Wealden at a depth about 4,700 feet. Initially production was 50 to 60 barrels daily. Subsequently, an extension well was completed with production of about 125 barrels a day.

3. Velden field, located in Bavaria, discovered by Mobil Oil. While the first well drilled in this field, Velden 1, was not encouraging, Well 3 proved that regular production on the order of about 200 barrels per day can be produced from a depth of about 5,000 feet in the Ampfing sand at the base of the Tertiary.

4. Ratzel Z 1, a wlidcat test drilled by C. Deilmann-Gewerkshaft Elwerath-Preussag-Wintershall in April 1960, on a structure defined by reflection seismic about five miles northwest of the Itterbeck-Halle gas field, found production of about 1.7 million cubic feet per day. Production is from the main dolmite of the Zechstein at a depth of about 7,500 feet.

Great Britain . . . oil and gas search likely to expand. Gas storage capacity is stressed

EXPLORATION ACTIVITY should increase in England following the awarding of 1,357,440 acres in new licenses to Esso Petroleum Company. Rights on 13 areas were sought because of geological similarity to the oil-productive Paris Basin in France, on trend across the English Channel. Natural gas prospects in the area are a consideration also. These licenses, located in southeastern England in Kent, Sussex, Surrey and Hants counties were applied for in December 1960 and granted on April 1, 1961.

This will be Esso's second attempt to find oil in the United Kingdom. The former Anglo-American company (now Esso Petroleum Co. Ltd.) was active during the 1937-1947 period when some 16 wells were drilled, including 1 in south England.

TABLE 1—Production and development drilling in Great Britain in 1960

(All by BP Exploration Co. Ltd. except Esso Petroleum Ltd.'s Midlothian field)

Field	Crude Oil Production 1960 Total Bbls.	1960 Bbls. Daily	1959 Bbls. Daily	% Diff. in 1960	Crude Oil Producing Wells at End of Year	Field Wells Drilled in Year Oil	Gas	Dry	Total	Footage	Wells Drilling End of Yr.
Apleyhead[1]	659[1]	2[1]	....[1]	100.0	1	1	..	2	3	12,034	..
Bothamsall	116,205	317	159	99.4	13	3	..	4	7	23,297	..
Caunton	6,295	17	21	— 19.0	10	..	..	..	..	..	..
Corringham	27,084	74	45	64.4	3	1	..	1	2	6,402	..
Cousland[2]	.....	....	....	.....	...[3]	..	..	1	1	187	..
Duke's Wood Eakring[4]	149,072	407	471[5]	— 13.5	122	..	..	..	..	..	..
Egmanton	206,424	564	716	— 21.2	35	1	..	..	1	3,520	..
Eskdale[2]	....	....	....	.....	...[6]	..	..	..	..	..	..
Formby	549	2	2	.....	8	..	..	..	[27]	1,011	..
Gainsborough[8]	30,671	84	26[8]	223.1	3	2	..	1	3	16,077	1
Kelham Hills	55,303	151	159	— 5.0	39	..	..	..	..	..	..
Kimmeridge	.....	....	51	—100.0	...[9]	2	..	1	3	3,433	..
Langar	....	....	....[10]	.....	....	..	..	..	..	..	..
Plungar	25,108	68	71	— 4.2	8	..	..	..	..	..	..
South Leverton[1]	4,246	12	....[1]	100.0	1	1	..	..	1	8,585	1
Midlothian	560	2	....[11]	.....	2	..	..	..	..	..	..
Total, 1960	**622,176**	**1,700**	**1,721**	**— 1.2**	**245[12]**	**11**	**..**	**10**	**23[13]**	**74,546**	**2**
Total, 1959	628,309	1,721	.....	.....	257	14	1	5	26	103,471	4

[1] 1960 discovery. [2] gas field. [3] 1 gas well on production. [4] Eakring is north of Duke's Wood on same structure. [5] 371 for Duke's Wood and 100 for Eakring. [6] Two old gas wells reworked and producing in 1960. [7] 2 wells drilled and 3 deepened for insitu combustion project. [8] 1959 discovery. [9] 3 oil wells shut in. [10] 90 barrels total or less than 1 bpd in 1959. [11] Unreported. [12] All producing oil wells evidently on artificial lift. Total excludes 3 shut-in oil wells and 3 producing gas wells. [13] Includes 2 wells completed for insitu combustion project.

1960 results. BP Exploration Co. Ltd. continued to produce its oil fields in the east Midlands, and at Formby on the English west coast near Liverpool. The new Broadbench 1 discovery at Kimmeridge in Dorset, south England was not commercially produced last year and 3 oil wells at Kimmeridge were shut in at the end of December (Table 1).

Crude oil production declined slightly last year to 622,176 barrels, an average of 1,700 bpd, down 1.2 percent from the 1,721 bpd rate of

1959. Most of the crude yield was from Egmanton, Duke's Wood-Eakring, and Bothamsall fields in that order. However, all three of these main fields had smaller outputs last year than in 1959. Increased yields from the newer Corrington and Gainsborough oil fields helped offset this decline.

Drilling activity lessened in 1960 when 29 completions aggregated 95,329 feet of hole, compared to 35 finished wells and 135,613 feet in 1959. The 1960 drilling statistics were virtually equal to those of 1958.

BP Exploration Co. Ltd. placed most emphasis on drilling of 21 development wells mainly in Bothamsall, Corringham, Gainsborough and Kimmeridge oil fields (Table 1). Eight wildcats were also completed. (Table 2). Shallow gas was indicated at Twyford, Buckinghamshire in lower Lias or Rhaetic, a wholly new producing horizon and area. Small oil discoveries made in 1960 in the east Midlands at Apleyhead and South Leverton were being evaluated in 1961.

Small amounts of natural gas continued to be delivered to the Scottish Gas Board from the one-well Cousland field located southeast of Edinburgh. Methane was found in 1937 in the first well drilled in Scotland near Dalkeith on the D'Arcy-Cousland anticline in lower Carboniferous. A second well completed in 1954 was dry.

BP reworked two old gas wells in North Yorkshire at Eskdale during 1960, and had them on production at the end of December. Gas was being sold to the North Eastern Gas Board. The original Eskdale gas discovery was made in the upper limestone of the Permian in a test drilled in 1937 to 4,040 feet. Initial potential was 2.5 MMcfd of nearly pure methane. A second gas well was completed in the lower limestone in 1954.

Interest in gas in Britain is also stressed by the gas storage evaluation program underway in the Hampshire Basin at Winchester, 70 miles southwest of London. Five holes were drilled between the fall of 1959 and February 1961. The first test was drilled to 2,104 feet by the British Gas Council and drilled deeper by BP to test the Jurassic. The four additional tests averaged about 1,500 feet in depth. Interest in gas in Britain is not so much in production, which is apt to be minor, as in storage which will become vitally important if a system to utilize imported methane becomes operational.

TABLE 2—Exploratory wells drilled in Great Britain in 1960
(BP Exploration Company Limited)

Name of Wildcat Well Location or Locality	No. Wells Completed in 1960	Total Depth (feet) and Results, 12-31-60
Bingham 2	1	2,888 dry
Blyton 1	...	4,762 drilling
Grove 1	1	5,161 dry
Harton 1	1	5,804 dry
Marsh Gibbon 1	1	572 dry
Twyford 1	1	514 possible gas prod.
Apleyhead 1*	3*	4,813* oil
South Leverton 1*	1*	5,125 oil*
Winchester No. 1	1	5,844 dry

* Included in Table 1.
Note: Total footage of wildcat dry holes and gas discovery completed during 1960 was 20,783 feet. Figure excludes stratigraphic drilling to about 1,500 feet at Winchester for possible gas storage.

In other drilling, BP completed 2 wells and deepened 3 others last year for the Formby field insitu combustion project.

Pipe lines. In March, 1961, the possibility of creation of a company to build a national pipe line network received some publicity. Debate was expected in the House of Commons as to whether legislation should be provided to permit construction of a national pipe line grid.

Demand. The *Financial Times* reported a 16.9 percent rise in U. K. oil consumption to 42.7 million tons in 1960 compared to 36.5 million tons in 1959. Hence demand has reached about 850,000 barrels daily. Fuel oil use is making the strongest gain; diesel oil use apparently is cutting into demand for gasoline. British oil demand growth will be watched with interest even by independent producers to determine the effect of future international methane shipments.

Greece . . . three rigs active in mid-1961

A BURST of exploratory activity is occurring in Greece, following passage of the Greek petroleum law of May 4, 1959, and ratification by the Greek Parliament of five petroleum exploration and development agreements by March 10, 1961. These agreements, and results therefrom as of mid-1961 are described as follows:

- Helios S. A. (Greek interests), joint venture with the French Regie Autonome des Petroles (RAP) covers 1,109,000 acres in Greek Thrace. Orestias 1, located on a seismic structure, was spudded November 1, 1960 and drilled to 6,500 feet by the end of December. In February 1961 it was abandoned as dry at 7,000 feet in Tertiary clastics. Orestias 2, located about 3 miles northwest of 1, was spudded February 20, 1961 and reached 3,400 feet by mid-April. RAP was obligated to spend at least $950,000 for exploratory drilling in Thrace.
- Esso Hellenic Inc. has 961,000 acres in western Peloponnesus and the Ionian Islands of Zakinthos and Paxi. Esso's first well, Zakinthos 1 was spudded on the west-central part of the island on February 4, 1961 and reached 5,730 feet (in carbonates) by mid-April. The well was projected to 8,000 feet to test Jurassic and (possibly) older rocks. Some lost circulation trouble was encountered above 4,500 feet in an almost solid carbonate section.
- W. H. Hunt signed a concession agreement with the Minister of Industry in Athens last September covering 1,173,250 acres both on and offshore in the Salonika vicinity, and did some seismic and gravity work before ratification of the deal by parliament on March 8, 1961. Hunt's first wildcat was being drilled below 10,263 feet on July 10, 1961. Hunt was obligated to spend $6.4 million in eight years.
- Aetolian Oil Co. S A, composed 49 percent by British Petroleum Company and the remainder by Greek interests (National Bank of Greece) has a 1,417,000-acre concession in Aetolia-Akarnania mainland and the islands of Lefkas and Cephalonia in Western Greece. Operations are conducted by BP Exploration Co. (Greece) Ltd. Exploration rights last for 8 years and an exploitation concession would be for 30 years, possibly extendible for 10 more years. Minimum expenditures in eight years is to be $7.6 million.
- Two other oil exploration pacts have been approved. A team of Rumanian technicians under Greek Government supervision will look for petroleum in the Kardista-Kalambaka-Grevena area of central Greece. Some shallow (300 feet) gas is reported near Kardista. Also, the French Petroleum Institute is working jointly with Greek specialists in the Epirus and north Grevena area. A drilling location near Ioannina has reportedly been recommended.

Italy... big gas fields reported in southern part of country. Oil output remains far below needs

THE CHANGE in exploratory emphasis from the Po Valley in the north to east-central and southern Italy during the past two years has paid off handsomely.

First came the discovery of the Ferrandina gas field during 1959 in southern Italy, 60 miles southwest of Bari. In recent months, important new gas discoveries have been reported at Pisticci, 10 miles southeast of Ferrandina and near Vasto on the Adriatic coast.

Natural gas reserves at Ferrandina are estimated at 355 billion cubic feet, allowing a production average of about 6.8 MMcf per day. The new Vasto and Pisticci fields are believed to have about the same reserve potential as Ferrandina.

This new development is particularly important to Italy, in that the Vasto and Pisticci fields are located in areas where industrialization has made little progress in the past because of inadequate fuel supplies.

According to ENI's original plans, a large amount of the gas in the southern fields was to be moved to Rome and elsewhere. However, strong objections from the local populace resulted in a decision to utilize most of the fuel locally.

Some of the gas from the Vasto field will be transported 120 miles to Rome. About one-third of the Ferrandina production will be used in an ENI petrochemical plant to be built locally. Another third will be used in nearby municipalities. Tentative plans are to sell the final third to Montecatini and others who may build additional plants locally.

Development of new gas reserves also may slow down Italy's plan to build a natural gas line from Tunisia to Sicily, then across the Messina Straits to the Italian mainland and possibly on into western Europe. SOSIM, an Italian company, was organized in 1960 to study the feasibility of piping Libyan and Saharan natural gas to the European mainland.

Production. Crude oil production in Italy continues far below the country's needs. The total last year was about 846,010 barrels, an average of 2,311 barrels per day. Production comes mostly from Cortemaggiore, Tramutola, Vallecupa, and Cigno fields.

Natural gas production from the Po Valley fields totaled 229,547 MMcf in 1960, an average of 628.9 MMcf per day, for an increase of 6.2 percent over the 592 MMcf per day produced during 1959.

Drilling. Seventy-nine wells, including 36 new producers, were completed in the Po Valley region last year, totaling 426,476 feet of hole. This represents a 19.7 percent increase in total wells drilled last year, compared with 1959. In 1959, there were 66 wells drilled and 327,341 feet of hole cut in the Po Valley.

In Peninsular Italy, 89 wells were drilled last year including 40 new producers, aggregating 461,379 feet of hole. This compares with 100 wells, including 41 producers, drilled in 1959 for a total of 476,577 feet of hole.

Thus, the total of 168 new wells drilled in Italy last year amounted to 887,855 feet of hole, compared with 166 wells for 803,918 feet in 1959.

Of the total wells drilled last year, 69 were gas producers, 7 were oil wells and 92 were dry holes.

TABLE 1—Drilling in Italy in 1960

Adapted from The American Association of Petroleum Geologists *Bulletin* 45, No. 7, (1961)

Area and Company	Wells Completed: Development Wells Productive	Development Wells Dry	Development Wells Total	New Pool and Outpost Tests Productive	New Pool and Outpost Tests Dry	New Pool and Outpost Tests Total	New Field Wildcats Productive	New Field Wildcats Dry	New Field Wildcats Total	Total Wls.	Footage Drilled (Feet) 1960	Footage Drilled (Feet) 1959
Po Valley	24	13	37	5	6	11	7	24	31	79	426,476	327,341
AGIP Mineraria[1]	23	10	33	5	6	11	6	19[4]	25	69	398,399	302,341
Other Firms[2]	1	3	4	..	..	..	1	5	6	10	28,077	25,000
Peninsular Italy	25	18	43	10	3	13	5	28	33	89	461,379	476,577
AGIP Mineraria[1]	20	4	24	10	3	13	2	19	21	58	320,551	300,113
Petrosud	4[5]	8[5]	12	..	..	..	2	0	2	14	64,978	150,300
Other Firms	1	6	7	..	..	..	1	9	10	17	75,850	26,164
Total, Italy[3]	49	31	80	15	9	24	12	52	64	168	887,855	803,918
Total, 1959	46	35	81	8	8	16	9	60	69	166	.....	803,918

[1] And affiliates. [2] Excludes shallow drilling for gas associated with salt water in Po Delta area. [3] Mainland. [4] Not including activity in exploration for natural gas associated with salt water in Po Delta. [5] Including new pool and outpost tests.

Mediterranean... first stratigraphic well reported being drilled

THE ONLY ACTIVITY indicated in the various Mediterranean islands outside of Greece was a stratigraphic test reported under way in Sardinia in the spring of 1961.

In Sardinia, Societa per Azioni Idrocarburi Sardegna (SAIS), composed of the West German Wintershall A G and local government interests, has a concession covering 3,500 square miles of the west half of the island. Geological and geophysical work has been done.

Sardinia has a fairly recent oil law (enacted in December 1959) which fixes maximum sizes and other terms of oil exploration and exploitation permits. It provides a sliding scale of royalties to the government based on quantity of production. No production had been found as of mid-1961.

In Cyprus, Forest Oil Corp. still held an exploration license in April 1961 covering most of the island. Forest was awaiting completion of the new Cyprus government's organization before renewing the oil search. The British colonial government ended in August 1960.

The Netherlands . . . search proceeding offshore; production of both oil and gas up

THE SEARCH FOR OIL in Holland is proceeding offshore, continuing the trend westward from the first oil production at Schoonebeek on the German border to more recently developed fields near The Hague and Rotterdam. Nederlandse Aardolie Maatschappij (NAM), owned 50 percent by Royal Dutch Petroleum and 50 percent by Standard Oil Co. (New Jersey) applied officially to the Dutch government late in 1960 for a permit to drill three wildcats in the North Sea. These wells were to be drilled from the mobile drilling platform "Triton" outside territorial waters between 5 and 10 miles off the Dutch coast, between Noordwyk and Kykduin.

Exploration in 1960 netted a minor oil discovery at Lekkerkerk in western Holland eight miles east of Rotterdam; and two interesting gas finds in the northeast near the West German border. Delfzijl 1, located 18 miles northeast of Groningen, and Slochteren 2, about 1.6 miles north-northwest of the 1959 Slochteren 1 gas discovery, both found gas. A third test, Grootegast 1, drilled about 15 miles west of Groningen town, was being tested at the end of December.

These gas discoveries were the subject of considerable local public interest and received some exaggerated publicity. Slochteren 1 was completed in a tight Permian-age gas horizon. Slochteren 2 had about 600 feet of sub-Zechstein Permian gas pay. Although the 2-trillion cubic feet figure mentioned as to possible reserves of the new field was probably premature, these gas discoveries definitely enhance sub-Zechstein trends in The Netherlands and West Germany.

Production. Crude oil production amounted to 13,165,583 barrels in 1960, an average of 35,971 bpd. This was 2,406 bpd or 7.2 percent higher than the 33,565 bpd rate of 1959. Production continued to rise toward the end of the year, with 38,137 bpd having been produced last December.

Schoonebeek field declined last year to an average of 17,747 bpd, down 2,195 bpd or 11 percent from the 19,942 average of 1959. Schoonebeek thus produced less than half of Dutch crude production in 1960 (49.3 percent, compared to 59.4 percent in 1959 and 71.7 percent in 1958). Schoonebeek continued to decline toward the end of 1960, with 16,745 bpd being produced in December.

In western Holland, IJsselmonde and Ridderkerk fields, located a few miles east of Rotterdam, have now been merged into one field and are so reported in production statistics (Table 1).

Natural gas production increased abruptly in 1960 to 10,629 MMcf, an average of 29.04 MMcfd, about 43 percent above the 1959 total of 7,411 MMcf. Production from both eastern and western sectors increased last year. The yields were 7,648 MMcf (20.9 MMcfd) and 2,981 MMcf (8.14 MMcfd) respectively.

Drilling continued actively with three NAM strings running throughout 1960 and one contract rig working during the first eight months. Total footage was 198,522 feet of hole, of which 158,299 was development and 40,223 was exploratory footage. Drilling was intensified in IJsselmonde-Ridderkerk field, where 26 wells were completed. A dry hole, Spijkenisse 1, was completed eight miles southwest of Rotterdam. In the east, 17 wells were completed at Schoonebeek and 5 in the De Wijk gas field. Three of the latter group were dry.

Portugal . . . wildcat drilling resumes

WILDCATTING IN PORTUGAL was temporarily suspended after Mobil Exploration Portugal, Inc. withdrew as contractor for Companhia dos Petroleos de Portugal in 1959, following a series of dry holes. The drilling

TABLE 1—Crude Oil Production, Producing Wells, and Oil Field Drilling in The Netherlands in 1960

REGION and FIELD	Wells Completed					Wells Drilling, End of Yr.	Oil Wells Producing at End of Year				Producing Zone		Crude Oil Production			
													1960			1959
	Footage	Oil	Gas	Dry	Total		Flowing	Pumping	Other Art. Lift	Total	Depth (Feet)	Formation	Total Bbls.	Bbls. Daily	BPD Dec.	Bbls. Daily
EASTERN																
Schoonebeek	48,551	15	..	2[1]	17	..	..	276	26	302	2,500	L C[3]	6,495,550	17,747	16,745	19,942
WESTERN																
IJsselmonde/Ridderkerk[2]	73,303	23	2	1	26	..	37	6	..	43	3,100; 5,000	L C[3]	3,303,131[2]	9,025	11,949	4,558
Wassenaar	8,095	..	..	..	..	1	9	2	7	18	4,200	L C[3]	1,699,334	4,643	5,166	4,138
De Lier	9,415	..	2	..	2	..	2	2	18	22	5,200	L C[3]	635,703	1,737	1,667	1,598
Zoetermeer	..	..	..	..	..	..	..	7	..	7	3,200	L C[3]	393,448	1,075	967	950
Pijnacker	6,367	..	..	1	1	..	3	3	..	6	5,800	L C[3]	342,706	936	944	1,078
Rijswijk	.....	..	..	..	..	..	..	..	5	5	2,500; 5,100	L C	196,886	538	421	1,019
Moerkapelle	.....	..	..	..	..	..	..	3	..	3	[7]	L C[3]; J[4]	27,381	75	63	100
Berkel	.....	..	..	..	..	..	..	3	..	3	3,100; 3,700	L C[3]	22,660	62	49	66
Meyendel	.....	..	..	..	..	..	..	1	..	1	4,200	L C[3]	17,609	48	105	59
Werkendam	.....	..	..	..	..	..	..	1	..	1	6,500	J[5]	10,356	28	28	30
Alblasserdam	.....	..	..	..	..	..	..	1	..	1	4,800	J[6]	9,099	25	21	2
Delft	.....	..	..	..	..	..	2	1	..	3	3,100; 3,800	L C[3]	6,890	19	11	25
Lekkerkerk	.....	1	..	..	1	..	..	1	..	1	.....	J[6]	4,830	13	1	.....
Sub-Total	97,180	24	4	2	30	1	53	31	30	114	.....	.....	6,670,033	18,224	21,392	13,623
Total	145,731	39	4	4	47	1	53	307	56	416	.....	.....	13,165,583	35,971	38,137	33,565
Total, 1959	150,985	17	1	9	27	2	47	302	23	372	.....	.....	12,251,462	33,565	33,463	33,565

[1] One of these wells is a water injection well. [2] Production from the IJsselmonde and Ridderkerk field are tabulated together rather than separately as before. [3] Lower Cretaceous Sands. [4] Jurassic calc. sandstone. [5] Jurassic siltstone. [6] Jurassic sand. [7] Moerkapelle pays are at 2,400, 3,200, 3,800 and 4,400 ft.

program has since been renewed, according to AAPG *Bulletin* 45, No. 7 (1961).

A gravity survey was conducted north of Lisbon in a salt diapir area, and some core drilling and surface geology were also done in Portugal in 1960. Monte Real West 5 was spudded October 31, 1960, and abandoned in January 1961 at 4,470 feet in upper Jurassic, with non-commercial oil shows having been tested in the upper Cretaceous.

A recent event appears to enhance the market for domestically-produced gas, as well as oil, if found. Domestic gas requirements in Lisbon were expected to be supplied starting in mid-1961 from the SACOR refinery (S. A. Concessionaria da Refinicao).

Sicily . . . concession acreage off

MODERATE EXPLORATION and drilling activity was reported in Sicily last year, while crude oil production was increasing 20.2 percent.

As in 1959, wildcat drilling was disappointing, particularly for the private companies. As a result, the total area of exploration permits dropped to 2,358,686 acres from 3,369,890 acres in 1959 and 4,080,449 acres in 1958. A 782,000-acre concession operated by Monsanto Chemical's Lion Oil Co. and an Edison of Milan subsidiary was dropped after eight dry holes were drilled.

Production. Sicily's production increase is attributed almost solely to ENI's Gela field, where the crude oil output increased from 1.4 million barrels (3,775 barrels daily) in 1959, to 3,377,152 barrels or 9,227 barrels daily last year.

Gulf Italia's Ragusa field, Sicily's largest, recorded a slight drop in production during 1960, from 9.33 million barrels (26,583 barrels daily) in 1959, to 9.29 million barrels or 25,382 barrels daily. By the end of 1960, the Ragusa field had produced a cumulative total of nearly 39 million barrels of crude.

The small Dirillo field, discovered by ENI affiliate AGIP Mineraria three miles southeast of the Gela field in 1959, produced an average of 555 barrels of 12° API gravity crude per day during 1960.

Thus, Sicily's crude oil production totaled 12.9 million barrels or 35,164 barrels per day last year, compared with 10.7 million barrels or 29,328 barrels per day in 1959.

Sicily's crude oil reserves are estimated at 340 million barrels, and natural gas reserves at 300 billion cubic feet with most of the natural gas production coming from the Catania field and some from the much smaller Cisina and Rizzo fields.

Drilling. A total of 43 wells, including 23 oil wells, 1 gas well and 19 dry holes involving 227,168 feet were completed in Sicily during 1960.

ENI's Gela field continues to be an active drilling area. Eighteen oil wells and 6 dry holes had been completed, and 5 more wells were drilling at the end of 1960. After an active drilling program in 1958 and 1959, only 3 development wells were completed in the Ragusa field last year.

Gulf Italia drilled four dry wildcats during 1960. The Margherite 1, spudded in 1959 northeast of Ragusa, was abandoned at 5,722 feet. The Grammichele 1 and Cono 1, also in the Ragusa concession, were abandoned at 4,949 feet and 8,550 feet respectively. The Conte 1, a stratigraphic test west of Ragusa, was drilled to 2,500 feet. Gulf Italia suspended drilling between July 24 of last year and January 1961. The company conducted only six man-days of geological field work and no geophysical work during the year.

AGIP Mineraria completed six wildcats in the Gagliano area and one in the Bronte area of northeast Sicily in 1961, with one producer.

The producer was Gagliano 1, with initial tests indicating 1.2 MMcf wet gas and 25 barrels of 58° API gravity crude per day from each of two sandstone beds at 8,250 feet and 8,900 feet. From the electric logs several levels with similar characteristics to the producing zones were indicated, but had not been tested. A second well about 3,300 feet from the first was still drilling at the end of 1960.

Also, AGIP Mineraria completed one productive well each in the Cammarata and Dirillo fields, following their discovery in 1959 and 1958 respectively. The productive oolitic limestone at Cammarata appears to be correlative with black shales forming the cap rock for the Triassic pay zones in the Gela field.

Private Italian companies drilled only four wildcats and three stratigraphic holes last year, and all were dry.

Refining and petrochemicals. The Gela field is expected to go on full production next summer, upon completion of a new petrochemical plant that will process the field's crude oil.

The elaborate new plant, authorized by the Italian and Sicilian governments, will be managed by a newly formed group, ANIC-Gela, and will have a capacity to process 50,000 barrels of crude daily. An associated power station will be fueled by petroleum coke. The plant will manufacture numerous other products.

ACKNOWLEDGMENT

The source of some of the information on Sicily is AAPG *Bulletin* 45, No. 7 (1961).

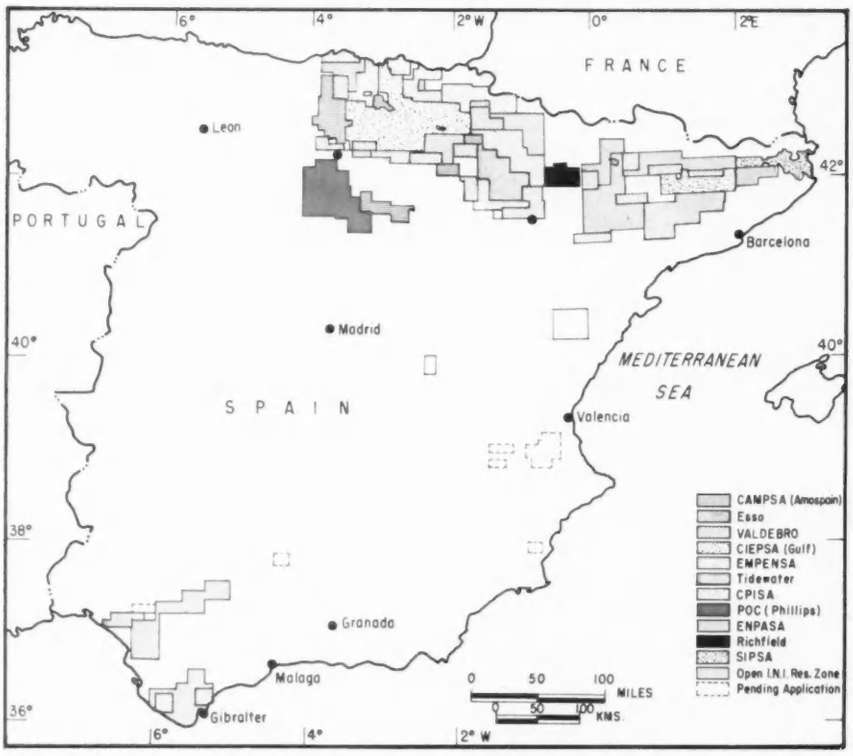
TABLE 1—Crude Oil Production, Producing Wells, and Drilling in Sicily in 1960, by Companies and Fields

Company, Field, and API Gravity of Oil	Production		Producing Wells	Wells Completed in 1960					Wells Drilling Yr. End
	Total Barrels	Bbls. Daily		Oil	Gas	Dry	Total	Footage	
Gulf Italia, Ragusa, 19.4°	9,289,775	25,382	46	3	..	4	7	39,341	..
AGIP Mineraria, Gela, 7.3°	3,377,152	9,227	33	18	1	6	25	136,527	5
AGIP Mineraria, Dirillor-Cammarata	203,115	555	4	2	..	..	2	.....	..
Other Companies	.....	.....	..	..	..	9	9	51,300	..
Total Sicily	12,870,042	35,164	83	23	1	19	43	227,168	5

Spain . . exploratory activity increasing

THE OIL SEARCH continues in Spain, one of the world's few remaining salt plug and diapir provinces without commercial oil and gas production. Pursuant to the petroleum law which took effect December 26, 1958, a series of exploration permits have been granted in the nation's two most prospective areas, the Ebro Basin in northern Spain and the Guadalquivir Basin in the extreme southwest. Exploratory activity is increasing following clarification of the acreage situation in 1959 and 1960.

EXPLORATION PERMITS IN SPAIN IN 1961



The Ebro Basin in northern Spain has been largely blanketed with exploration permits since adoption of the new oil law late in 1958. Some interest in the Guadalquivir Basin in the extreme southwest is also in evidence.

Drilling. Nine wildcats were completed in Spain last year, aggregating 88,806 feet of hole. As in past years, many oil and gas shows were reported but suitable hydrocarbon-saturated reservoir rocks were not found. Table 1 is a listing of dry holes completed last year.

Five additional wildcats were being drilled at the end of December, two by VALDEBRO, and one each by CAMPSA, CIEPSA, and SIPSA. About a dozen or more completions were expected in 1961.

Important changes are taking place in the oil search picture as both private Spanish and outside capital are joining with government entities to form exploration combines.

General American Oil Company of Texas and other U. S. interests continue to operate VALDEBRO in conjunction with the Spanish government's wholly-owned Instituto Nacional de Industra (INI). Last year General American reduced its interest in the U. S. group to 56.33 percent. The U. S. group and INI share expenses equally and will likewise share any production after a 10 percent royalty to the government.

Pan American International Oil Corp. filed for exploration permits last year covering 250,000 acres. Other U. S. firms are active in Spain (see map). West German interests (C. Deilmann Bergbau GmbH) have been active in Spain for several years. Recent reports indicate French participation also.

Refining. The Ohio Oil Co. and its Spanish associates plan to build a 25,000-bpd refinery on the north coast of Spain. The $18 million plant is expected to be on stream by 1964 and will process Libyan crude. Spain's two existing refineries, the 80,000-bpd government-operated Cartagena plant and the 60,000-bpd Tenerife refinery may not be able to fulfill Spain's product needs much longer since demand now exceeds 100,000 bpd.

TABLE 1—Dry Holes Completed in Spain in 1960

Operator and Well	Total Depth (Feet)
Valdebro, Bujaraloz 1	9,268
Pamplona 3	14,548
Pamplona 4	5,627
Zaragoza 1	7,391
Monesma 1	15,584
Ciepsa, Castillo 1	14,268
Urbasa 1	12,584
Zufia 1	3,468
Cpisa, Sopenano 4	6,068

Spitsbergen...

oil prospects look good

American Overseas Petroleum Ltd. and Royal Dutch Shell both conducted geological reconnaissance in this far northern Archipelago last summer. Amoseas filed claims on about 200 equal tracts aggregating about 50,000 acres, and planned for three helicopter-supported geological crews to continue the work during the current summer season.

Spitsbergen is essentially a coal-mining camp, administered by Norway. Mining claims (including the right to produce petroleum) must be published in the local press, inviting any counter-claimants to protect their rights. Despite this rather awkward legal procedure, Amoseas was confident of getting permits.

Data on Spitsbergen's possibilities have been previously published in World Oil (August 15, 1960, Page 145, and February 1, 1961, pp. 27-32).

Switzerland...

wildcatting slows in 1961

A flurry of exploratory drilling took place in Switzerland in 1960, but slackened somewhat by mid-1961. BP Exploration S. A. Fribourg spudded its first test, Courtion 1, about 6¼ miles northwest of Fribourg on June 17, 1960. The well was abandoned at 10,117 feet in November, reportedly in the Triassic at total depth. BP's second test, Sorens 1, ten miles south-southwest of Fribourg was then spudded and was drilling at 1,768 feet at the end of December. The well was reported drilling below 6,560 feet in the spring of 1961.

The Schweizerisches Erdoelforschung A G (SEAG) Kusnach 1 test south of Zurich city and near the east shore of Lake Zurich, was spudded in April 1960. It was reported abandoned last summer at 8,850 feet.

In Canton Vaud north of Lake Geneva, the French firm Societe de Prospection et Exploitations Petrolieres en Alsace (PREPA), as operator and 75 percent participant, joined

SWITZERLAND

minority U. S. interests and drilled Risoux 1, located near the French border. The well reached 3,400 feet by the end of December. The test was reported abandoned in 1961.

Also in Vaud, the West German firm Elwerath spudded in a seismic prospect at Savigny on June 4, 1960. The Vaud acreage held by Societe Anonyme de Hydrocarbure of Lausanne had been previously farmed out to Elwerath as operator. Elwerath drilled this test to 8,156 feet in lower Cretaceous and abandoned it.

In 1961, more interest in the northeastern cantons of Thurgovie and Zoug was expected, following an oil discovery on trend in West Germany near Friedrichshafen. Also, BP was expected to drill its third test on the Alterswill structure, about 5 miles east of Fribourg.

EASTERN EUROPE

Russia... expansion of oil and gas output and petroleum exports planned

RUSSIA IS RAPIDLY improving its position as an oil power, if available information is correct. The Soviet Union is the center of a complex oil trade with the Eastern Europe satellite countries which it dominates. And since the Soviet oil industry has increased its producing ability greatly, its impact on world oil trade has sharpened.

Russian crude production in 1960 amounted to 1,080,400,000 barrels, or 2,951,912 barrels daily, an increase of 433,000 bpd or 17.2 percent over 1959. The nation's natural gas output of 1,660 billion cubic feet in 1960 was a rise of 27 percent from 1959. Cumulative crude production from the October Revolution in 1917 to the beginning of 1960 was 10,950,000,000 barrels, of which 50 percent came from the Baku area.

In an effort to surpass U.S. crude production in 1972, Russia has set an interim target for 1965 of 1,752,000,000 barrels, or a daily average of 4.8 million barrels.

The number of flowing wells reportedly has almost doubled in the past nine years. Average production per well has more than doubled, due chiefly to new oil fields discovered in the Volga-Ural area.

Trade. Hand in hand with Russia's growing importance as an oil producer goes its export capability. Of the daily average production of 4.8 million barrels expected to be produced in 1965, it is planned that 2,750,000 barrels a day will be for domestic consumption and that 2,050,000 barrels daily will be channeled into export trade.

Domestic requirements in 1960 totaled 2.5 million barrels daily, as compared with 2,213,000 bpd in 1959. Russia's excess supply over demand increased from 435,000 barrels a day in 1959 to about 500,000 bpd last year.

The 1965 plans have been outlined by D. I. Maslakov, described as an oil expert in the Soviet State Planning Commission. It was further explained that the planned production for 1965 is expected to be overfulfilled by 160,000-200,000 barrels per day.

Currently, Russia's share of the world oil trade amounts to about 4.5 percent. Moscow's intention is to expand its share of this trade in proportion to its ability to produce. The immediate aim appears to be a 19 percent share in the world trade, a percentage which the Russians had in the early 1930s. But Radio Moscow had claimed this expanded share in trade will be achieved "not at the expense of Arab countries."

Russia Increases Share of World Production, As U.S. Share Steadily Decreases
(Thousands of Barrels per Day)

Year	World Total	U. S. A. Total	U. S. A. % of World	U. S. S. R. Total	U. S. S. R. % of World
1952	12,380	6,256	50.5	924	7.5
1954	13,745	6,342	46.1	1,128	8.2
1956	16,733	7,151	42.7	1,630	9.7
1958	18,091	6,710	37.1	2,208	12.2
1959	19,480	7,054	36.2	2,519	12.9
1960	20,944	7,035	33.6	2,952	14.2

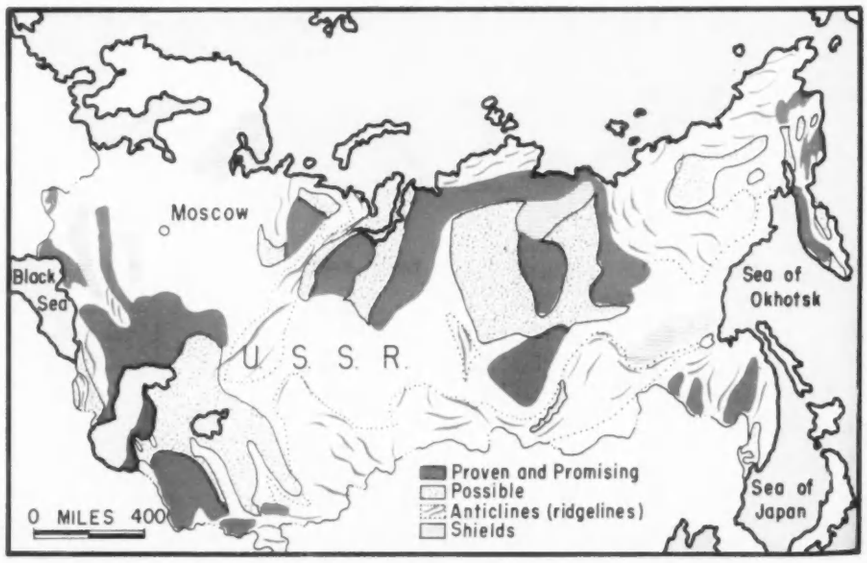
A summary of Russia's complex crude oil and products trade activities in 1959, the latest year for which figures are available, follows, with 1958 figures in parentheses for comparison:

With 1959 imports of 7.9 million barrels of crude oil and 24.4 million barrels of products, Russia exported 91.1 million barrels of crude (66.4 million barrels in 1958) and 94 million barrels of products (66 million barrels in 1958).

Of these exports, the Iron Curtain countries imported 43.5 million barrels of crude (35.2 million barrels in 1958) and 35.3 million barrels of products (27.3 million barrels in 1958).

Western European imports from Russia amounted to 35 million bar-

PETROLEUM AND NATURAL GAS PROVINCES OF USSR



rels of crude in 1959 (15.4 million barrels in 1958) and 43.3 million barrels of products (28.8 million barrels in 1958).

Imports of Russian crude and products by other Free World areas included 12.6 million barrels of crude (15.7 million barrels in 1958) and 14.7 million barrels of products (9.7 million barrels in 1958).

Italy, Red China and Sweden were listed as major non-satellite importers of Russian oil.

Since Russia began in 1958 to equip its chemical industry with complete plants from West Germany, England, France, and Italy, its need for foreign currency has increased. This need is being met primarily from export oil sales in non-satellite countries, despite the fact that crude oil and products often are sold at "dumping" prices.

The low prices are mostly offset by the extremely high prices charged the satellites for Russian oil imports.

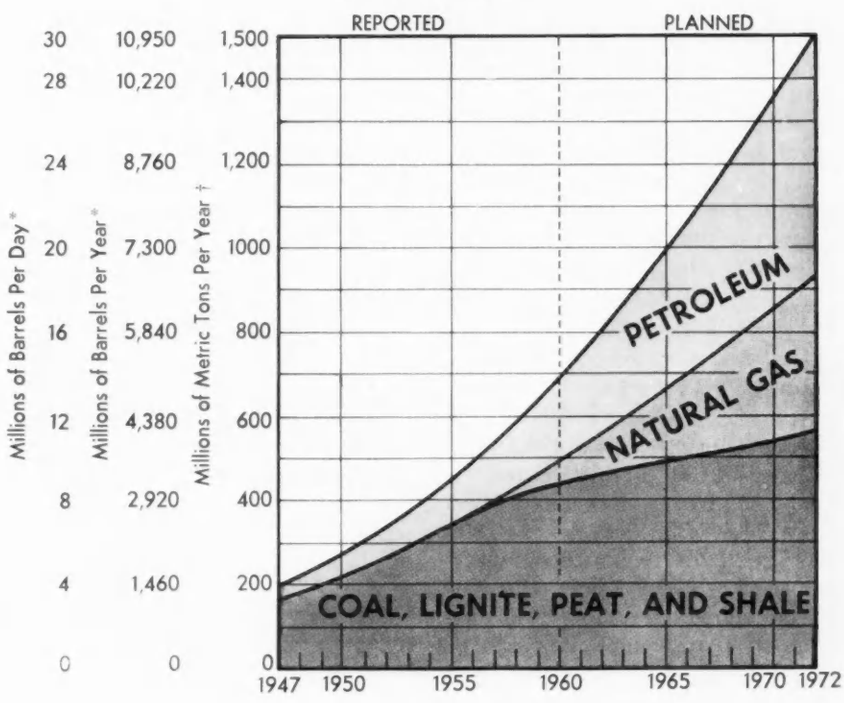
Reserves. Indications are that Russia's proved crude reserves may be on the order of 23,579 million barrels and that probable reserves may reach as high as 51-58 billion barrels. During the past decade, crude reserves reportedly increased fourfold, and prospects for the discovery of additional crude are believed good.

The latest estimate of Russian natural gas reserves puts the level at 70,620 billion cubic feet, with 85 percent of the reserves concentrated in 17 fields. To date, almost 200 gas fields have been discovered, with the most important located at Kuybyshev, Saratov, Astrakhan, Krasnodar, Stavropol, Gazli, and in the Ukraine.

Drilling. Only reports on exploratory drilling are available from the Russian oil industry. Footage in this category which was drilled last year amounted to 13,124,000 feet, with an increase scheduled for 1961 so as to reach 16.7 million feet. A total of 317 structures were to be explored by deep drilling this year. Between 1959 and 1965, plans call for 40 million feet of exploratory drilling.

Pipe Lines. While in 1960, 1,277 miles of oil pipe lines were to be constructed, in addition to 2,273 miles of natural gas pipe lines, this year's schedule reportedly called for the building of 2,129 miles of natural gas pipe lines and 1,860 miles of oil pipe lines. The most important gas pipe lines projected for the year 1961 include the Gorkiy-Ivanovo-Yaroslavl-Cherepovets-Ivetsevichi-Vilnius line, the Korobkiy-Storoshevka line, and the Tashkent-Chimkent pipe line. The three major oil pipe lines are the second line from Almetyevsk to Gorkiy, the Kaltasy-Yasykovo-Ishimbay project, and the Pensa-to-Bryansk pipe line.

REPORTED AND PLANNED SOVIET MINERAL FUEL OUTPUT (1947-1972)



Average Multipliers Physical To Conventional Metric Tons: Petroleum 1.43, Natural Gas (1000 m³) 1.27, Coal and Lignite 0.78, Peat 0.41

* One Metric Ton = 7.3 Barrels
† 7,000 C/kg Heat Equivalent

RSFSR. Exploration last year in the Russian Soviet Federated Socialist Republic, the USSR's largest republic, led to the discovery of 28 oil fields, 16 natural gas fields and 2 oil and gas fields. In addition, 33 new oil zones and 9 new gas horizons were discovered in known fields.

Deep exploratory holes were drilled in 424 oil fields, of which 120 fields are in the Volga region, 111 in the Ural area, 89 in the northern Caucasus, 70 in West and East Siberia, 12 in the north of the European part of the RSFSR, and 13 were in the Far East. Footage drilled last year amounted to 8,875,105 feet, reportedly an increase of 7 percent from 1959.

The most interesting result of 1960 wildcatting was the opening of the Shaim oil field in Western Siberia, where three exploratory wells, varying in depth from 4,692 feet to 4,922 feet, have begun producing. Another discovery awaiting development has been found at Novosibirsk.

The Kuybyshev area has almost caught up with the Tatar and Bashkir republics in crude production. In Bashkiria, the Troizk oil field, near Serafimovsk, began production from several zones in August, 1960. Tataria is expected to become Russia's leading oil-producing republic by 1965.

Uzbekistan. During 1960, deep tests explored seven oil and gas deposits. Recoverable natural gas reserves are estimated at 21,186 billion cubic feet. All 12 gas fields are concentrated in the Kysyl Kum desert. Uzbekistan is expected to become the third largest oil and gas producing republic in Russia by 1965.

Kazakhstan. Exploration during 1958-1960 in the western sector led to the discovery of three major oil fields—Kenkaik, Burunkul and Prorva. On Mangyshlak peninsula, the Shetybai oil deposit, covering an area of 54 square miles, was discovered. Thirty-six deep drilling rigs cur-

rently are in operation in this republic. By 1980 Russia expects Kazakhstan to be producing at the rate of almost 800,000 barrels of crude daily and almost 3.5 billion cubic feet of natural gas per day.

Kirgizia. Last year, the Buta-Karin oil field was discovered at a depth of 12,005 feet. The highest exploration ever carried out in Russia was in the Chu and Issyk-Kul valleys, 5,578-6,562 feet above sea level.

Ukraine. A new field south of Chernigov was discovered last year.

Azerbaidzhan. Planned daily oil and gas production for 1960 was 350,640 barrels and 637 MMcf. During the year, the Kalmas gas field was reported discovered, and oil was found at Kara-Bagly. Four hundred wells up to 16,000 feet deep are scheduled to be drilled during the next five years. The daily production target for 1961 was put at 370,000 barrels, and for 1965 it was set for 440,000 barrels.

Turkmenia. Preparations were made early in 1961 for the development of oil fields in the southeastern part of the Caspian Sea. As in Azerbaidzhan, Turkmenia is constructing steel dams from which offshore wells will be drilled.

Estonia. Oil shale production during the next 20 years is to be increased, according to Russia, by five times to 800,000-840,000 barrels per day. For this purpose, five open-cast mines and six pits with a daily capacity of between 40,000 and 50,000 barrels are scheduled to begin operation.

Bulgaria . . . rise in exploration is planned

After a decrease in 1959, Bulgaria's crude oil production rose in 1960 by 365 barrels daily or 10.4 percent to 1,460,000 barrels or 3,989 daily. In 1959 it amounted to 1,322,600 barrels, or 3,624 daily. Cumulative production reached 9,497,300 barrels at the close of 1960. As of Jan. 1, 1961, crude oil reserves were estimated at 15,330,000 barrels.

Although an exploratory well east of Novo Oryakhovo, Kamchia district, discovered Bulgaria's first natural gas field, the utilization of natural gas has not progressed. Traces of natural gas were found at Blatnitsa, near the Rumanian border, and in March 1960 gas shows were reported at Zlaten Rok, near Vidin, at 387 feet.

Drilling. Bulgarian oil experts agreed at the Varna meeting in March 1960 that exploration activities were to be intensified. In June, new Rumanian and Russian rigs were used to explore in the Gorna Oryakhovitsa-Dyaskovets area. Additional test drilling was carried out at Spassovo, in Tolbukhin district, and at Gnoynitsa, in Mikhailovgrad district.

Exploration footage is scheduled to be increased from the 98,430 feet drilled in 1959 to 196,860 feet in 1965. Footage for deep holes, a separate classification, is planned to be increased from 72,180 feet in 1958 to 442,940 feet in 1965.

In February, 1961, Rumania agreed to assist Bulgaria in geological exploration, and planned to send experts and drilling equipment to implement the program.

By 1965, assuming the same crude production as in 1960, Bulgaria's annual crude output will supply only 8 percent of domestic demand as compared to 40 percent in 1956. This is expected because consumption will rise, it is forecast, to 18,250,000 barrels a year.

OIL AND GAS FIELDS AND REFINERIES IN BULGARIA

Burgaria's only industrial oil field was discovered at Tyulenovo in 1951. Since 1954 it has produced 9.5 million barrels. The country's only gas field, at Novo Oryakhovo, was discovered in 1955. The Soviet Union is building a 40,000-bpd refinery at Burgas.

Albania . . . crude oil production sets record

If information which has filtered out of Albania is correct, this Russian satellite reached a new high in crude oil production in 1960. Output for the year, claimed to be a total of 4,023,783 barrels, or 10,994 daily, would represent an increase of 2,224 bpd or 25.4 percent over 1959 and a gain of 2,041 bpd or 22.8 percent over 1957, the previous peak.

World Oil has been told that the planned production level between 1961 and 1965 is scheduled to rise by 57 percent.

With crude reserves estimated at 667,200,000 barrels, based on available information, and with Europe's largest asphalt deposits at Celenika,

OIL DEVELOPMENTS IN ALBANIA

First oil in Albania was found by Italians in 1918. Commercial production began in 1938. Oil fields are located in the Patos-Stalin-Devoli triangle. In recent years the Soviet Union built a 3,000-bpd refinery at Cerrik, an oil pipe line from Patos via Stalin to Cerrik, and products lines from Cerrik via Stalin to the port of Valona.

these two products are Albania's most important export items. With only a small refining capacity, the country exports crude and asphalt to Russia, Hungary, Bulgaria, and Italy.

Drilling. Experts from Russia and other satellite countries are assisting in geological exploration, which in 1960 was concentrated in 12 unidentified areas. During the current Five-Year Plan (1961-1965), objectives include the discovery of "two new oil fields, with one of them ready for production in 1963, and at least 10 new oil horizons in known fields are to be readied for production."

During this period, total footage to be drilled is put at 1,148,350 feet.

Albania's crude oil is produced from three fields: Patos, the most productive, which covers an area of 4.63 square miles, Devoli and in the Myzequeya lowland. The Stalin fields, exploited by the Italians, have become almost depleted. No figures have ever been reported on the number of wells or footage drilled in any of the past years.

Crude Oil Production in Albania Sets New Record

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1938	880,704	2,413	1955	1,694,688	4,643
1947	760,608	2,084	1956	1,934,880	5,287
1948	600,480	1,641	1957	3,267,712	8,953
1950	880,704	2,413	1958	2,690,130	7,370
1953	1,334,400	3,656	1959	3,201,050	8,770
1954	1,567,920	4,296	1960	4,023,783	10,994

Czechoslovakia . . . 50 percent increase in production planned by 1965

CZECHOSLOVAKIA'S 1960 CRUDE PRODUCTION of 929,134 barrels, or 2,538 daily, was a gain of 259 bpd or 11.6 percent over 1959. Between 1960 and 1965 crude production, under national planning, is expected to increase 50 percent. No natural gas production data have been made available since 1958, when output amounted to 40.11 billion cubic feet.

Oil is produced at Gbeli and Hodonin, in western Slovakia, and at Mikhalovce and Zemplin, in eastern Slovakia. Natural gas production is located at Sekovce, Liskovce, Lab, and Vysoka. Three-fifths of the Vysoka field extends into Austria.

No official figures are available on Czechoslovakian crude oil reserves. However, Western experts generally put the level at an estimated 10,851,200 barrels.

Drilling. Recent exploratory drilling at Mikhalovce led to the discovery of a new natural gas deposit near Trhoviste at 1,968 feet. Other natural gas discoveries were reported from northeast Moravia and the adjacent part of northwest Slovakia (Caca, Dolni Nemci, Slosovice, and Rozvadov). Oil traces were encountered near Lipa during shallow drilling operations for the construction of an earthen dam.

The national average well depth is 5,110-5,850 feet. Recently, more wells have been drilled to 8,200 feet and even to 9,840 feet. Soviet experts now are drilling at Hodonin to 13,124 feet.

East Germany . . . exploration increasing

STATISTICAL INFORMATION on East Germany's oil industry has remained a well-kept secret since oil and gas exploration began in 1951. The 1960 plan called for the drilling of 165 exploratory wells in 10 prospective areas. Whether this number was drilled and what the results were remain unreported.

Planned production in 1960 was 2,992-3,989 barrels daily. It is extremely doubtful whether East Germany will be able to produce by 1965 the planned 20,000 barrels daily of crude or the 19.4 MMcf of natural gas per day.

In 1960 Russian experts joined German seismic and geological crews in the Mecklenburg area, where Russian turbodrills have been in operation since 1958. In all, about 20 Russian, Rumanian, Austrian, and German deep drilling rigs are available. Since 1954 exploration has been concentrated in the areas of Ludwigslust, Hagenow, and Parchim (in Mecklenburg), and at Weimar and Rudersdorf (in Thuringia). Development of the natural gas fields at Langenzalza and Muehlhausen has been continued.

Since East Germany's crude production has failed by far to meet domestic demand, annual crude imports are expected to rise from 9,344,000 barrels in 1960 to 35 to 36.5 million barrels in 1965, with Russia supplying 95 percent.

Hungary . . . oil and gas production higher

HUNGARY'S CRUDE OIL production of 9,270,450 barrels or 25,329 daily in 1960 was 3,672 bpd or 17.2 percent above 1959. Natural gas production of 12 billion cubic feet showed a 3 percent rise. Through 1961, cumulative production since commercial production began in 1937 totaled 123,482,394 barrels of crude and 271.21 billion cubic feet of gas. For 1965, it is planned that crude production will be at an annual rate of 12.8-13.7 million barrels. Peak crude output occurred in 1955, averaging 33,467 bpd.

HUNGARY

A report in March 1961 said that between 1957 and 1960 crude reserves had trebled and natural gas reserves had increased tenfold. This would mean that current crude reserves are approximately 213.6 million barrels.

Drilling. Footage drilled last year amounted to 1,378,020 feet, an average of 42,653 feet per rig, as compared with 37,732 feet per rig in 1959. Available during the year were 31 Russian, Rumanian and Austrian drilling rigs.

Crude Oil Production in Hungary Sets 5-Year Record

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1937	19,403	53	1949	3,792,110	10,389
1938	326,541	895	1950	3,906,560	10,703
1939	1,097,125	3,005	1951	3,807,370	10,431
1940	1,910,682	5,220	1952	4,562,740	12,664
1941	3,220,913	8,824	1953	6,454,980	17,685
1942	5,078,765	13,914	1954	8,530,340	23,370
1943	6,393,940	17,517	1955	12,215,630	33,467
1944	6,181,460	16,889	1956[2]	9,172,397	25,061
1945	5,003,579	13,708	1957[3]	5,127,360	14,047
1946	5,148,510	14,105	1958	6,325,270	17,329
1947	4,346,300	11,908	1959	7,905,000	21,657
1948[1]	3,685,290	10,069	1960	9,270,450	25,329

[1] Oil industry nationalized. [2] Water encroachment at Nagylengyel. [3] After effect of October, 1956, uprising.

An oil deposit, described as a rich one, was found at Nagykoros in 1960. The Nagylengyel field, which produces two-thirds of the nation's crude output and Barabasszeg field have been developed further. Average depth of pay zones throughout Hungary is 6,560 feet.

Domestic crude supplied half of Hungary's requirements last year. The natural gas areas—Hajdusag, Totkomlos-Oroshaza, southern Zala, Babocsa, and Gorgeteg—supplied 15 percent of the country's primary energy needs. Currently, 7.4 billion cubic feet of natural gas is imported annually from Rumania through the 231-mile, 11-inch Sarmas-Tiszapalkonya pipe line.

Poland . . . depends on Russia for most of crude oil needs

With crude oil production of less than 4,000 barrels daily in 1960, Poland's slowly-developing petroleum industry is losing in its effort to supply any significant portion of domestic requirements. Again, it is Russia that supplies most of Poland's crude oil needs. During the past 15 years, the Soviet Union has delivered 66,780,000 barrels of crude and products. During the next five years (1961-1965), Russia will export to Poland 63,070,000 barrels of crude and 57,144,000 barrels of products. In 1960, Russia supplied all of the satellite's crude requirements of 5,297,880 barrels, as compared with 5,142,060 in 1959.

Domestic crude output in 1960 amounted to 1,442,448 barrels, or 3,941 barrels daily, an 11.1 percent increase over 1959. For 1965, the regime's planners look forward to output of only 4,065 barrels daily.

Currently, about 3,000 wells are capable of producing some oil. Most of the production is from between 1,740 feet and 2,300 feet.

Natural gas production increased last year by 29.5 percent to 19.4 billion cubic feet from 14.9 billion cubic feet in 1959. Gas production of 38.8 billion cubic feet is planned for 1965. At present, gas production supplies about 65 percent of the country's needs. During 1961-1965, the natural gas pipe line system is to be expanded by 435 miles to 1,391 miles.

Hitherto, crude reserves have been put at 25,228,000 barrels, but Henryk Gorka, director general, Krosno Oil Trust, claimed recently that the satellite's reserves of crude oil plus natural gas amount to the equivalent of 1.8 billion barrels of crude.

Trends in Oil and Gas Production in Poland

Year	Wells	Crude Oil Production		Natural Gas Production	
		Total Barrels	Bbls. Daily	Total Million Cu. Ft.	Million Cu. Ft. Daily
1949	3,220	1,123,237	3,077	5,438	14.9
1955	3,500	1,333,936	3,655	4,785	13.1
1956	3,549	1,362,774	3,723	13,887	37.9
1957	n.a.	1,340,547	3,673	15,376	42.1
1958	n.a.	1,298,325	3,557	12,240	33.5
1959	n.a.	1,297,575	3,555	14,965	41
1960	3,000	1,442,448	3,941	19,395	53

Total footage drilled in 1960 was reported by World Oil sources at 569,719 feet. Average footage per rig per month was set at 1,040 feet.

Exploratory drilling was concentrated in the Carpathian foothills in 1960. During the year, 26 oil wells began production in the Mielec area. In October, a test well near the Lubaczow gas field encountered oil bearing horizons.

Center of crude oil production is the southeast part of the country, where there are 43 oil fields.

Rumania . . . gas production rises sharply

A sharp increase in natural gas production highlighted Rumanian petroleum industry activities in 1960. With production in 1960 reported at 230,186 MMcf, up 13 percent from 1959, Rumania utilized 85 percent of its natural gas output. By 1965 flaring is expected to be limited to 5 percent.

As examples of the utilization of natural gas, the nation is developing a petrochemicals industry based largely on gas. Artificial fertilizer is produced at Victoria and Fagaras, synthetic rubber at Onesti, and new plants for the production of plastics, fertilizers, fibers, solvents, etc. are under construction at Borzesti and Craiova.

Crude oil output. The 1960 crude oil production of 85,169,000 barrels or 232,702 barrels daily was slightly above 1959's 231,447 bpd.

Old fields—Prahova, Dambovita, Buzau, and Bacau—accounted last year for 33 percent of total production, while fields developed after 1950—Oltenia, Pitesti and Moldavia—produced 67 percent. Producing wells totaled 4,660 during 1960. For 1965 an output of 247,543 barrels daily is foreseen.

Crude oil reserves as of Jan. 1, 1961, were estimated at 903,532,000 barrels. An increase in reserves during the next five years has been called the No. 1 task ahead for the nation's oil planners and developers.

Drilling. Total footage drilled in 1960 was 2,385,600 feet, of which two-thirds resulted from exploratory drilling. Between 1960 and 1965 footage is expected to rise markedly to 16.4 million feet.

Of interest, too, is the deep drilling program scheduled to get under way during 1961, when a number of tests are scheduled to reach 23,000 feet.

Yugoslavia . . .

crude output at new high

A 1958 OIL DISCOVERY in Yugoslavia led to record crude production in 1960. The field, at Struzec in Croatia, began producing in May last year, and at year's end it had more than 50 wells on production from about 3,200 feet. The pay zone is reported to be almost 500 feet thick. Struzec's crude oil reserves are estimated at between 73 million barrels and 182.5 million barrels, with continued development drilling necessary to narrow this estimate range.

Crude production last year of 6,883,900 barrels, or 18,808 barrels daily, was 59 percent more than in 1959. Output is expected to reach 26,550 bpd in 1961 and jump to 50,000 bpd in 1962.

Croatia fields produce about 80 percent of total crude output, and the remainder is supplied by Slovenia and Serbia.

A thorough reappraisal of the nation's crude reserves remains to be completed. It is reported that a conservative estimate would be 182.5 million barrels.

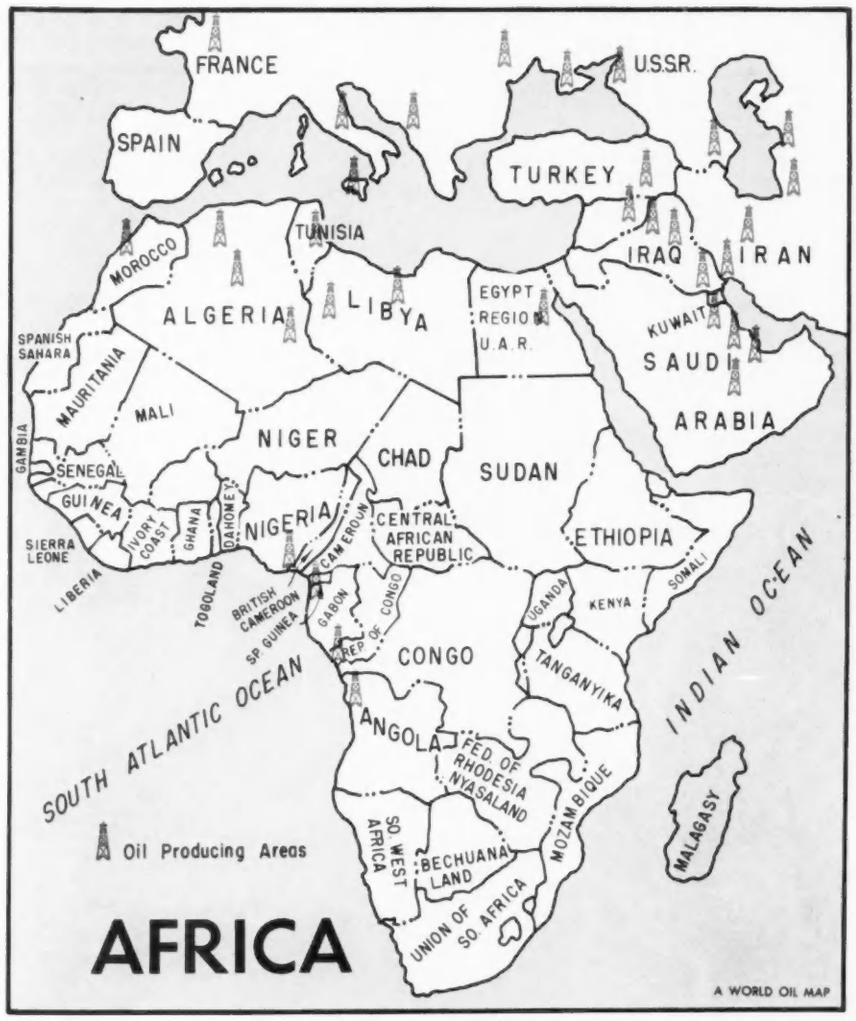
Natural gas. A slight increase in natural gas production also was reported for 1960—1,836 MMcf as compared to 1,765 MMcf in 1959.

Drilling. A total of $1.3 million was spent in 1960 on both exploration and development drilling. The first wildcat test of 1960, drilled at Lipovljane, near Novska, discovered oil in a pay zone with thickness ranging up to 131 feet.

Exploration activity in the Srem area has produced promising results, and activity will be continued south of the Tisa river as well as at Kladova and Morava. Oil impregnated zones at 7,950 feet were encountered in a wildcat test drilled at Musapstan, on the Dalmatian coast.

Yugoslavia's Crude Output Triples in Five Years

Year	Total Barrels	Bbls. Daily	Year	Total Barrels	Bbls. Daily
1939	7,700	21	1954	1,529,008	4,189
1949	447,107	1,225	1955	1,818,432	4,982
1950	777,700	2,131	1956	2,076,318	5,673
1951	1,047,300	2,869	1957	2,791,943	7,649
1952	1,071,367	2,927	1958	3,266,340	8,949
1953	1,216,577	3,333	1959	4,188,740	11,476
			1960	6,883,900	18,808



NORTHERN AFRICA

Libya . . . country is one of world's most active.

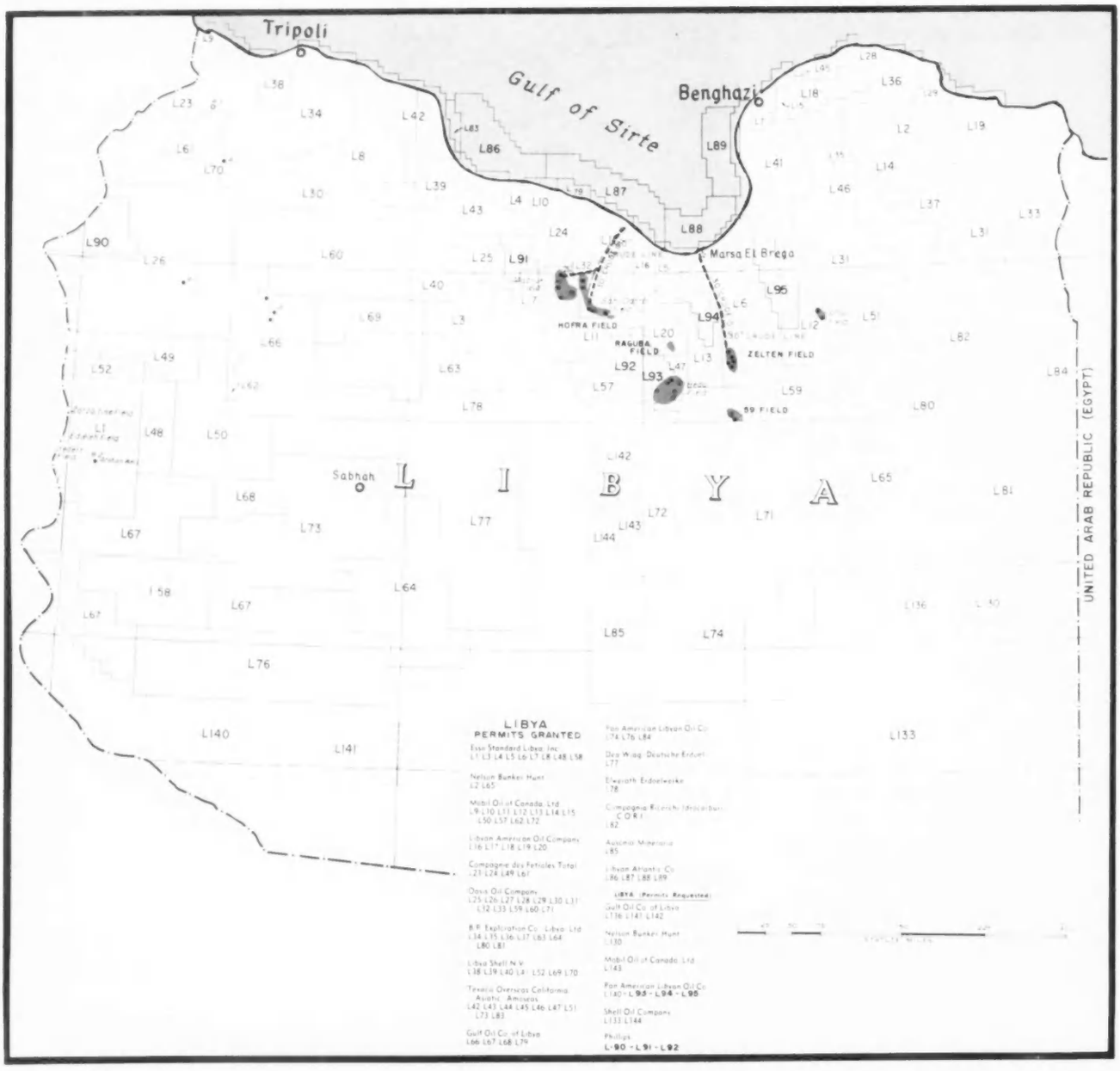
Seventeen established fields have 66 productive wells

WITH 66 PRODUCING wells in 17 established fields at the end of 1960, Libya moved into 1961 as one of the most active oil provinces in the world. A major factor responsible for this marked success has been the Libyan Government, whose "open door" policy has drawn U.S., British, French, German, Dutch, and Italian companies into the country. However, as oil prospects continually become better known and more thoroughly enhanced, the government is becoming more insistent on greater "Libyanization" of operations personnel-wise, and Libyan customs regarding imports of materials are becoming more burdensome.

Active operators at year's end numbered 18 companies. According to Libya's Petroleum Law of 1955, concession holders are required to relinquish 25 percent of their holdings after five years. This five-year period is up on some concessions, and these areas are being filed on. Remainder of the concessions to be dropped will come up intermittently in the future.

Libyan crude oil and natural gas production has been limited to test production, and no sale or export of crude oil has occurred. However, it is anticipated that facilities under construction now will make available the first delivery of crude from Libya to world markets before mid-1962.

OIL FIELDS, CONCESSIONS AND PIPE LINES IN LIBYA



Spectacular new oil discoveries continue to be made in Libya. Two large-diameter pipe line projects are underway. Esso Standard (Libya) Inc. hoped to start exporting crude oil from its Zelten field by the end of 1961. Prolific oil pays are being found in the Sirte Basin, which straddles the line between Zone 1 (Tripolitania) and Zone 2 (Cyrenaica). Zelten and Bahi-Dahra field areas probably represent a billion barrels each of primary recoverable oil. A recent development in the Sirte Basin is Eocene oil in Fifty-nine field, augmenting Paleocene-Cretaceous reef production found previously in Sirte. In western Libya, scattered discoveries have been made in thinner pays in Paleozoic and Triassic formations.

These facilities are a large diameter pipe line system, extending from Dahra field and Mabruk field in eastern Tripolitania to a deep water terminal to be built at Es Sider on the Gulf of Sirte. The over-all project provides for field gathering systems, communications and control system, seven 300,000-barrel crude oil storage tanks, and harbor equipment, such as work boats and derrick barge.

The contract for the facilities was let through Oasis Oil Co., of Libya, Inc. Oasis, operator in Libya for Amerada Petroleum Corp. of Libya, Continental Oil Co. of Libya, and Ohio Oil International of Libya, Inc., now is developing Dahra field in Concession 32. These three companies will own the pipe line system and terminal facilities jointly with three other companies who are developing Mabruk field in Concession 17. The three latter companies are Esso Sirte, Inc., Libyan American Oil Co., and W. R. Grace and Co. Oasis will supervise the construction and operate the facilities, to be known as the Sidrah Pipe Line System, for the six owners.

In addition, Esso Standard (Libya) began work on a 106-mile, 30-inch pipe line from Zelten field to the coast.

The outlook for continued high-level activity for the remainder of 1961 and 1962 appeared good, particularly since Libya's Petroleum Commission said this year it expects to maintain the traditional 50-50 profits division.

As of Feb. 1, 1961, producibility of all of the country's oil wells, based on tested zones, was put at approximately 112,500 barrels per day. Even this figure was expected to climb by the end of 1961 with continuing reports of new producing wells being completed by many of the operators.

During 1960, seven new producing fields were discovered—three by Gulf Oil Company of Libya, three by Oasis, and one by Mobil Oil of Canada Ltd. This compares with the discovery of seven oil fields in 1959 and three in 1958.

During the past year, drilling activities extended to 167 wells, with a footage figure of 923,604 feet. While drilling and seismic activity increased markedly, geological field work declined. Geological data on most wells drilled in Libya is withheld by operating companies since a renewed land play follows the relinquishing of acreage.

In 1960, exploratory tests extended to 129 wells, resulting in the drilling of almost 782,000 feet of hole. Thirty-eight development wells were drilled in Zelten field by Esso and in the Dahra field by Oasis for a total of almost 142,000 feet. Through 1960, the success ratio of all exploratory drilling was slightly over 14 percent. Last year, the 68 wildcats drilled included seven tests which found new oil fields, resulting in a success ratio for the year of more than 10 percent. Twenty-nine wells drilled during the year were classified as extension wells, and 14 were successfully completed. The remainder were dry holes.

Exploration activities included more than 475 party months of seismic operations, 277 geological field party months, and almost 50 gravity party months.

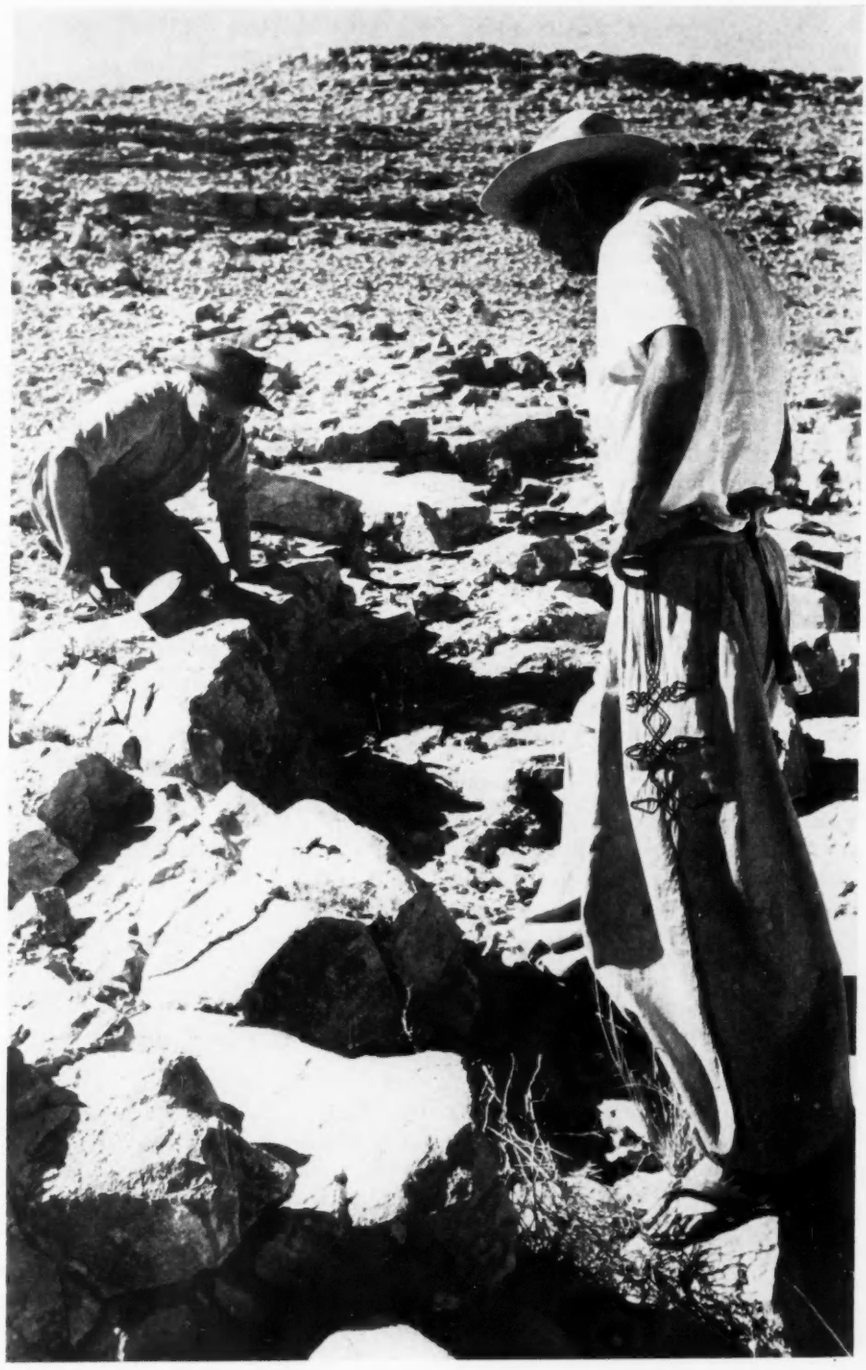


Photo courtesy Standard Oil Company (N.J.)

Geologic field party checks outcrop in a rocky surface area in Libya. Although much of Libya is covered with desert sand, many other areas can be readily worked by surface geological parties.

Companies with concessions in Libya include American Overseas Petroleum Ltd., Ausonia Mineraria, Compagni des Petroles Total (Libye), Cori, BP Exploration Company (Libya) Ltd., BP-Nelson Bunker Hunt, Deutsche Erdoel, Elwerath Oil Company (Libya), Esso Sirte, Inc., Esso Standard (Libya) Inc., Gulf, Libyan American Oil Company, Libyan Atlantic, Libya Shell N.V., Nelson Bunker Hunt, Mobil Oil of Canada Ltd., Oasis Oil Company of Libya, Pan American Oil Company, Cie. Francaise des Petroles, Phillips, and Pan-American.

Algeria . . . crude oil production increasing; politics clouds Sahara's future

ALGERIA'S OIL INDUSTRY was getting into full swing in mid-1961, but the political picture remained cloudy, with the future of the Sahara's mineral resources uncertain. Crude oil production increased in 1960 to 67,226,388 barrels, an average of 183,679 bpd, exceeding by far the 25,180 bpd average of 1959. The 410-mile, 22/24-inch pipe line from Hassi-Messaoud field to the Mediterranean port of Bougie was completed at the end of 1959, and Hassi-Messaoud was on flush production all last year. Early last fall the new 24-inch pipe line from Edjele-Zarzaitine fields to the Tunisian port of Skirra north of Gabes was opened and an additional 100,000-bpd (or larger) crude oil production source was thus tapped.

However, in mid-1961 the Tunisian pipe line was shut down in the dispute between Tunisia and France over the naval base at Bizerte. Apparently such trouble was partially anticipated by the French, since a new large-diameter crude oil line had been very rapidly built early in 1961 connecting Ohanet field in eastern Algeria with the Hassi-Messaoud-Bougie pipe line system. The newest large crude line was due for testing in June 1961, and apparently will provide an alternate outlet for Edjele, Zarzaitine and Tiguentourine if it is desired to extend it to connect these fields.

Production. Hassi-Messaoud was the most prolific Algerian field last year; 52,400,617 barrels was produced, an average of 143,171 bpd. This figure includes 33,684,434 barrels produced by Societe Nationale de Recherche et de'Exploitation des Petroles in Algerie (S N REPAL), or 92,034 bpd; and 51,137 bpd, amounting to 18,716,183 barrels for the year, by Compagnie Francaise des Petroles (Algeria) (CFP [A]).

The new Hassi-el-Gassi-El-Agreb field, located about 50 miles south-southwest of Hassi-Messaoud was scheduled to go on production in May 1961. The new field has been tied into the Hassi Messaoud-Bougie system by a 10-inch pipe line extension.

A small volume of crude oil was also produced in 1960 by Compagnie Algerienne de Recherche et d'Exploitation Petrolieres (CAREP) from the old Oued Gueterini field, located about 100 miles southeast of Algiers. The total last year was 32,161 barrels, an average of 88 bpd, slightly higher than in 1959.

In eastern Algeria, Compagnie de Recherches et d'Exploitation de Petrole au Sahara (CREPS) produced 14,793,610 barrels, an average of 40,420 bpd, most of it during the latter part of the year after the new pipe line to Tunisia entered service. The total included 11,176,975 barrels from Zarzaitine field and 3,616,635 barrels from Edjele.

Following rapid development of the Ohanet oil field, discovered by Compagnie d'Exploration Petroliere (CEP) and Mobil International Oil Co. north of Zarzaitine, production may start soon since the field is in excellent position relative to either the new large diameter line to Hassi Messaoud or the one to Tunisia. At least 60 million barrels of recoverable reserves had been proven at Ohanet by early 1961.

Since progress has been made in construction of pipe lines from Hassi R'Mel gas-condensate field, REPAL expected to commence gas production this year. Planned outputs were about 28.5 MMcfd and 1,650 bpd of gas and condensate respectively. These quantities were to be doubled in 1962 and quadrupled in 1963.

Drilling. There were 184 completions in Algeria last year, according to fig-

TABLE 1—Drilling and Production in Algeria in 1960*

Wells completed in 1960	**184**
Oil	124
Gas	14
Dry	46
Footage drilled in 1960, feet	**1,475,000**
Average depth per well, feet	8,016
Crude oil production in 1960, barrels	**67,226,388**
Barrels daily	183,679

*Adapted from AAPG *Bulletin* and *Petrole Informations.*

Tunisia . . . wildcat is spudded in south

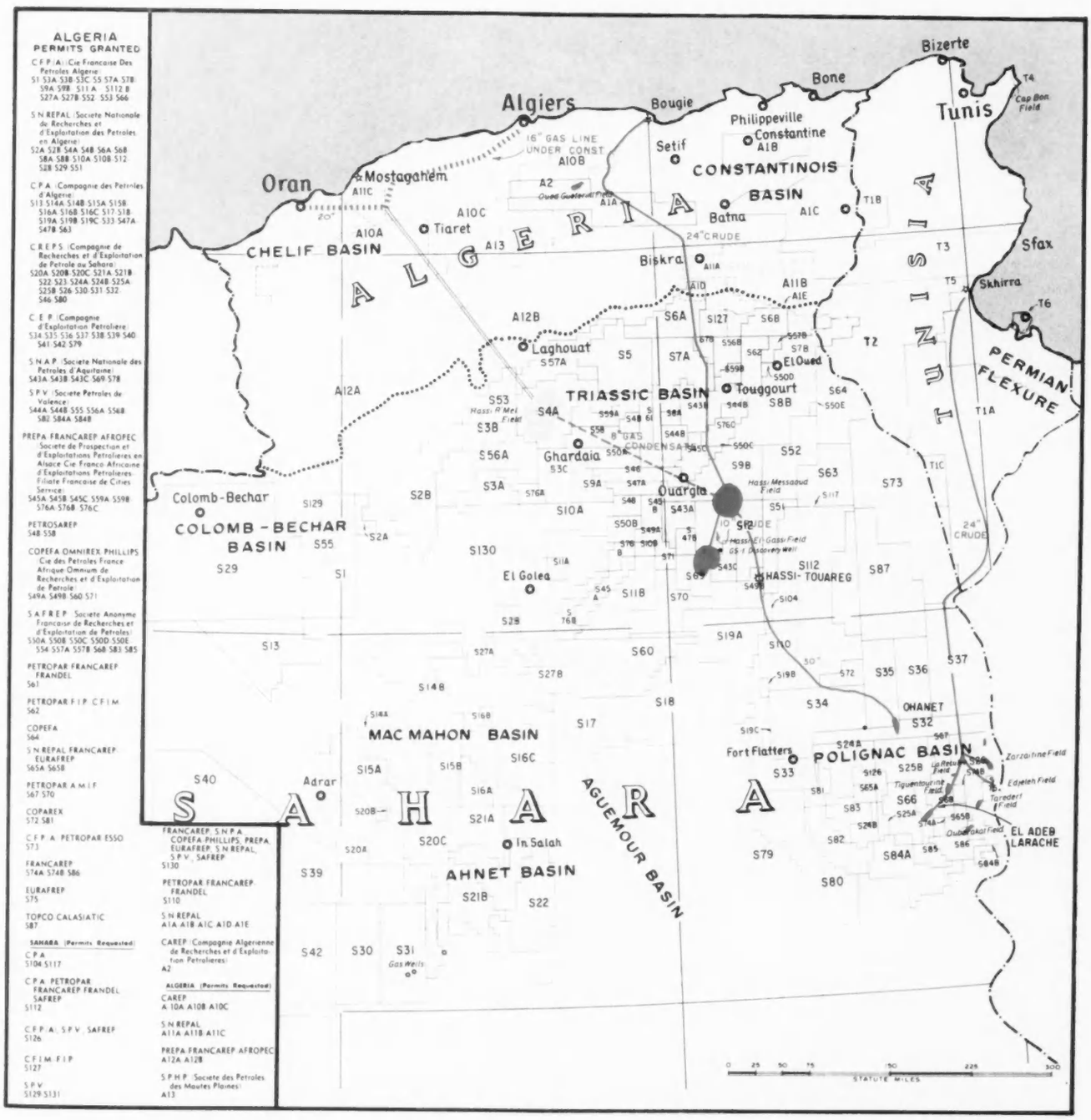
WILDCATTING began anew in Tunisia in 1961 after having been dormant since 1959. Societe de Recherches et d'Exploitation des Petroles en Tunisie (SEREPT) spudded Garet Ben Sabeur 1 on July 5, 1961 in extreme southern Tunisia and was drilling below 1,132 feet two weeks later. The location is 28 miles northwest of MG 1, a dry hole completed in 1959 near the Libyan border, about 83 miles north of Gadames. SEREPT has acquired a half-interest partner, Mobil Producing Tunisia, Inc., with SEREPT remaining the operator of the 12,925-square-mile permit in the extreme south.

Conorada Petroleum Corp. did a full year's seismic survey on its 10,000 square miles of permits in central-western Tunisia in 1960, concentrating mainly on refraction work. Conorada was optimistic about this work in early 1961 and expected to drill some wildcats in Tunisia within the next several years.

SEREPT continued to produce the small Cape Bon gas field in the extreme northeast near Tunis. Natural gas production last year amounted to 253,385,125 cubic feet, an average of 692,309 cubic feet daily. Natural gasoline production amounted to 10,850 barrels, or 96 bpd. Natural gas yield in 1960 was more than 13 percent above the 1959 figure.

Italy's ENI has proposed to form a joint Italian-Tunisian firm to build a refinery to process 20,000 bpd initially for domestic use. The plant was to receive Algerian crude from La Skirra pipe line terminal; but the 24-inch Edjele-La Skirra line and terminal were shut down during the political dispute between Tunisia and France during mid-1961. ENI has applied for a large exploration permit along the coast south of Gabes to the Libyan border, north of the SEREPT-Mobil acreage.

OIL AND GAS FIELDS, SEDIMENTARY BASINS AND PIPE LINES IN ALGERIA



Large oil and gas reserves continue to be proven in the Triassic Basin in the northern Sahara and in the Polignac Basin near the Libyan border. The huge Hassi-Messaoud oil field in northern Sahara is augmented by El Agreb field, and a new Triassic oil discovery has been made in 1961 northwest of Hassi-Messaoud. Recently the first oil field in the Constantinois Basin has been confirmed at Djebel Onk near the Tunisian border. New pipe lines serve all main producing regions, including the huge Hassi-R'Mel gas field.

ures published in AAPG *Bulletin* 45, No. 7 (1961). Of the 136 development wells listed in this tabulation, 116 were completed for oil and 5 for gas, with the remaining 15 dry. Wildcatting showed good results too, with 8 oil wells and 9 gas wells included in the 48 completions. About 1,475,000 feet of hole was reported drilled during the year, and 40 rigs were reported in Algeria at the end of December.

Drilling was heavily concentrated in Hassi-Messaoud, Zarzaitine, and Tiguentourine-La Reculee fields last year. By the latter part of 1960 the productive trend at Hassi-Messaoud had been extended to a length of about 31

miles and a width of about 28 miles. More than 80 oil wells had been completed in Hassi-Messaoud since its discovery to the end of 1960.

CREPS was extremely active in development drilling last year. According to *Petrole Informations*, 41 wells, all producers, were completed at Edjele; and 19 wells, including 18 producers, were completed at Zarzaitine.

Exploration. In addition to the interesting Ohanet find already mentioned, the following discoveries are important also.

- The Djebel Onk oil discovery, the first in the Constantinois Basin, made by REPAL last year, appears to be commercial. Four productive wells had proved two pay zones at about 3,600 feet by the end of 1961
- Compagnie des Petroles France-Afrique (COPEFA) made three deep gas condensate discoveries on the Hassi Touareg permit in 1960. Pays were found in both Triassic and Ordovician
- PREPA-FRANCAREP-AFROPEC made an oil discovery early in 1961 about 50 miles northwest of Hassi-Messaoud field. About 75 effective feet of oil pay was found in Triassic sandstone stringers between 12,600 and 13,000 feet. The well was believed capable of producing about 2,000 bpd of 40° API crude. Several andesite flows were interspersed with the sand stringers. It was hoped that the Triassic would have better reservoir characteristics than the Cambro-Ordovician at Hassi-Messaoud and El Agreb.

Morocco . . . new oil sought to replace existing fields approaching depletion

EXPLORATION WAS BEING STEPPED UP in Morocco in 1960 and 1961, raising hopes that new oil finds in the future will replace existing oil fields approaching depletion.

All crude oil production in Morocco in 1960 was by Societe Cherifienne des Petroles (SCP). The total yield was 695,475 barrels, an average of 1,900 bpd. This was a decline of 2.7 percent from the 1,952 bpd rate of 1959, but well above the 1,534 barrels daily rate of 1958. About 65 percent of the 1960 output was from Haricha field in the Rharb Basin near Sidi Kacem. Haricha and upper Sidi Fili were the only fields to boost production above 1959 yields last year, while the other 11 producing reservoirs declined.

SCP completed 2 productive wells and 3 dry wildcats in the Rharb area last year, and was drilling wildcats at Sous and Essaouira at the end of December. The firm drilled 37,835 feet of hole in 1960. Natural gas was being sought as well as oil. A total of 332.8 MMcf (909 Mcf daily) was delivered via a 4-inch pipe line from Haricha field to the Sidi-Kacem refinery in 1960, according to AAPG *Bulletin* 45, No. 7 (1961). This was more than twice the amount of gas reported produced in 1959.

Societa Marocchino-Italiana dei Petroli (SOMIP) has an active exploration program. The firm has obtained three new permits in addition to one granted in March 1960, aggregating more than 2,300 square miles. Photogeologic, gravity and seismic surveys have been undertaken.

SOMIP's first wildcat, Oum Doul 1, spudded in November 1959 on the Tarfaya permit in the Tindouf Basin had reached 11,936 feet by the end of 1960 and nearly 16,000 feet by the spring of 1961, reportedly still in the Paleozoic. Hard quartzites and testing of oil shows in a few thin porous zones have delayed drilling. Puerto Cansado 1, near the coast, was spudded late last year on a seismic structure and was being drilled below 5,980 feet on December 31.

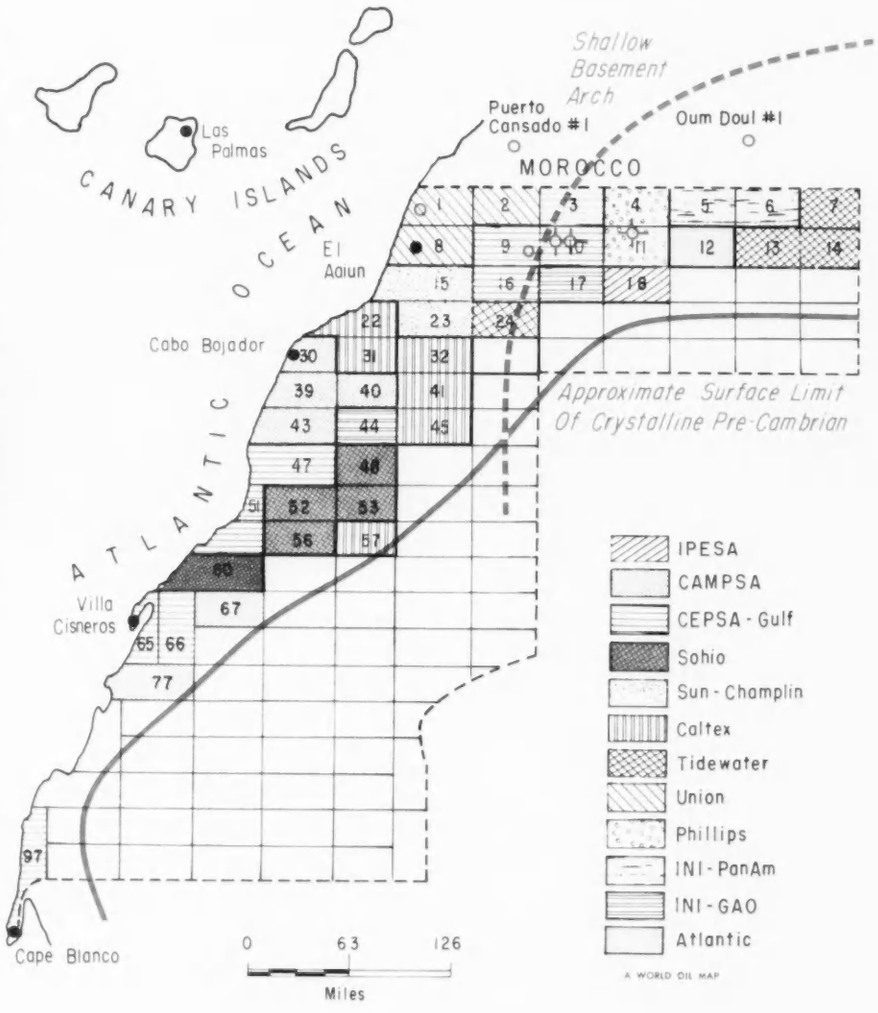
Early in 1961, Pan American International Oil Corp. was reportedly granted a 6-month exploration permit covering more than 1,000 square miles in northwestern Morocco.

Crude Oil Production and Drilling in Morocco in 1960*
(Societe Cherifienne des Petroles)

Crude oil production, bbls. in 1960	695,475
Bbls. daily in 1960	1,900
Bbls. daily in 1959	1,952
(% change in 1960)	−2.7
Wells completed in 1960	5
Oil	2
Gas	0
Dry	3
Footage drilled in 1960	37,835
Drilled in 1959	73,545
†Wells drilling at end of 1960	†2

*Adapted from *Petrole Informations*.
†Two additional wildcats being drilled by SOMIP. Footage accruing thereto to be carried over to year of completion.

Spanish Sahara contract exploration crews also dwell in tents. This is a gravity meter crew working on Pan American's Block 5 concession where exploration started in 1960.



Most of the acreage in sedimentary areas in the Spanish Sahara is now leased. (See map) Stratigraphic and full-hole wildcats are being drilled to determine prospects in Tindouf and coastal Mesozoic basins.

Spanish Sahara . . . drilling activity is under way as exploration proceeds rapidly

EXPLORATION IS PROCEEDING rapidly in the Spanish Sahara, an area almost unknown from a geological viewpoint as of the end of 1958. New permits were granted in 1960, and pertinent corporate and operating groups were finalized. Stratigraphic drilling began in 1960 and full-hole drilling started this year. Virtually all permit holders had started geological and/or geophysical work by mid-1961.

New concessions. Since last year's report was written (WORLD OIL, August 15, 1960, Page 160), Spanish Gulf Oil Co. and Compañía Española de Petróleos (Gulf-CEPSA) received permits along the Atlantic coast covering block 97 in the extreme southwest (Cape Blanco area) and blocks 65 and 66 in the Villa Cisneros vicinity. An interior permit (number 3) was also acquired in the north bordering Morocco. Gulf-CEPSA holdings now exceed five million acres as well as offshore rights in coastal permits.

Atlantic Refining Company added blocks 67 and 77 to its acreage in the Villa Cisneros vicinity, increasing holdings to two million acres.

The interior permit 18 (620,000 acres) was granted to a group composed 33½ percent by Magellan Petroleum Co. and Oil Investments, Inc. (Buckley interests, U.S.) combined as Investigaciones Petroliferas, S. A. (IPESA); 23½ percent Ausonia Mineraria (Montecatini—Italian interests); 33 percent Bureau de Recherche de Petrole (BRP—French interests) and 10 percent by the Spanish Instituto Nacional de Industria (INI). Hence, most of the Spanish Sahara's prospective acreage is under permits (see Map).

Drilling. All drilling done last year was stratigraphic in nature. Spanish Gulf drilled its A-1-10 test to 1,808 feet. Basement granite was found at about 1,800 feet directly under Cretaceous beds. The granite encountered was reported as belonging to the shallow basement arch which ties in with the Anti-Atlas mountain chain in Morocco (WORLD OIL, Special Report/North Africa, January 1961, Page 72).

The rig was moved 10 miles eastward and well B-2-10 was drilled to 5,838 feet, reportedly still in Devonian at total depth. These two tests indicate abrupt eastward thickening of the Paleozoic section in the Tindouf Basin, a relationship evidently confirmed by the Oum Doul test drilled in Morocco by Italian interests.

Gulf's third test in its strat-drilling program, E-1-9, located in the block

west of the first two wells, was drilling at 2,185 feet at the end of December. Thus Gulf's total footage of stratigraphic drilling last year was 9,831 feet of hole. E-1-9 and a fourth test were reported drilled to 5,600 feet or deeper in 1961.

Phillips Petroleum Co. had drilled a shallow hole for stratigraphic and ground water data to 1,655 feet in permit 11, by early 1961. Atlantic was also reported planning a stratigraphic drilling program.

From new geological data from Spanish Sahara, Morocco and extreme western Algeria, the Tindouf Basin is now better defined, and thickness of Paleozoic strata is much greater than heretofore thought. Reservoir conditions appeared to be poor in the thickest sequence explored thus far, but more coarse clastics and hence more favorable lithology were expected nearer to the shield. The middle Devonian thickens considerably in the western part of the basin, and an interesting reef play may develop since bioherms are known in this section in outcrops toward the south.

The Mesozoic Basin along the coast is poorly known; it may be similar to coastal Senegal and the Mogador area of Morocco. Small production is found in both regions. The first full-hole drilling in Spanish Sahara was started at Union Oil Company of California Daora 1-1, spudded near the northwest coast on March 1, 1961. This test was drilling below 3,000 feet later this year. Projected depth is 13,500 feet. Union's activity was prominently in the news in March 1961 when eleven members of a United Geophysical Company crew doing seismic work for Union near the Moroccan border were kidnapped and held captive for ten days. King Hassan II of Morocco ordered the men released.

Geophysical work is proceeding rapidly in the Spanish Sahara, with operating companies generally acquiring good seismic records. As of mid-1961 some offshore seismic work had been done and more was planned. Original country-wide coverage of the Spanish Sahara was by aeromagnetics; it is being supplemented both by conventional seismic and weight-dropping and by gravity work as individual firms' programs proceed.

French West Africa . . . eventful year

in Senegal raises hopes in area

MAURITANIA

EXPLORATION PERMITS cover the entire Mauritanian Atlantic coastal strip. On the north bordering Spanish Sahara, Societe de Participations Petrolieres (PETROPAR) received the five-year, 14,845-square-mile Port Etienne permit in April 1960. Adjoining this permit and extending southward to the Senegal border, Societe Africaine des Petroles (SAP) acquired the five-year, 11,400-square-mile Nouakchott permit during the same month.

U.S. capital is involved in both ventures. Continental Oil Co. of Mauritania has 24 percent interest in the Nouakchott permit and 25 percent participation in the Port Etienne venture. Both permits include a high proportion of offshore area.

This coastal strip is believed to be a continuation of the Mesozoic-Tertiary basin recently shown to be oil-productive in Senegal.

SENEGAL

SENEGAL passed an eventful year in 1960. Crude oil production began in what was evidently a one-well field, Diam Niade 4, located about 30 miles east of Dakar. Production from this late 1959 discovery began in mid-1960 and averaged about 60 barrels daily during the rest of the year. Crude oil output in 1960 was 12,537 barrels, an average of 34 bpd for the full year. Gravity is 37° API and the producing interval is 3,333-3,359 feet in upper Cretaceous sands, according to AAPG *Bulletin* 45, No. 7 (1961).

The operator is Societe Africaine des Petroles (SAP). This production is on the 4,000-square-mile Dakar permit. Wells Diam Niade (DN) 5, 6, and 7 were drilled to develop the new field, but none found the producing oil sand which appeared to be lenticular. Possible gas production was indicated in the area, however.

SAP's former St. Louis and Richard Toll permits have been grouped into a single 5,414-square-mile (St. Louis) concession. SAP as 26 percent interest holder and operator was to drill its first wildcat Toundou Besset 1 on this concession in 1961 about 15 miles northeast of St. Louis. Partners are Compagnie de Participations de Recherches et d'Exploitations Petrolieres (COPAREX), Continental Oil Co. and Cities Service.

Exploration in Senegal was also conducted by Societe des Petroles du Senegal (SPS). The deep test N'Dofane 1, near Kaolack about 120 miles southeast of Dakar was abandoned in February 1960 at 11,627 feet. The rig was then used to drill three structure holes in the north Casamance area just south of Gambia and was subsequently moved into Gambia to drill for the BP/BRP group.

Senegal became independent in August 1960. It was formerly a part of the Mali Federation. Its former sister-state, the ex-French Sudan, is now independent also. Evidently the Mali oil law will still govern operations in Senegal (WORLD OIL, August 15, 1960, Page 162).

MALI

SINCE THE FORMER MALI FEDERATION split up into its two original components, Senegal and the former French Sudan, last year, the Sudan portion has become the Mali Republic. This clarifies African terminology and avoids confusion between the former French Sudan (west Africa) and the former Anglo-Egyptian Sudan (east Africa). A similar problem of names still exists farther south between the ex-French Congo Republic and the nearby ex-Belgian Congo.

SAP in 1960 conducted some field geology in the Mali Republic, in the Bamako area and south of Tombouctou, according to AAPG *Bulletin* 45, No. 7 (1961).

Gambia . . . two wells drilled in 1960

BP/BRP Exploration Co. (Gambia) Ltd., jointly composed of British Petroleum Co. and the French Bureau de Recherches de Petrole, continued exploration in Gambia in 1960. Early in 1960 a seismic survey was conducted along the Gambia River. The operators planned a series of stratigraphic wells east and south of Linguere in Senegal and on the Bathurst peninsula in both Gambia and Senegal.

Brikama 1, located 15 miles south-southwest of Bathurst, was drilled to 6,904 feet last year and abandoned. Sarakunda 1 was drilling at 9,839 feet at the end of December.

BP reported 6 months of seismic work by a contract crew in 1960, and 2 months of aeromagnetic surveys which covered part of Senegal also.

Port. Guinea... three dusters dim hopes

Esso Exploration Guine, Inc. conducted active wildcatting on seismic prospects in 1960 and early 1961 with disappointing results. The firm was considering giving up the oil search. The decision largely depended on the outcome of Sao Domingos 1, an 8,500-foot test which was drilling ahead last April.

Safim 1, located 10.5 miles northwest of Bissau was spudded on October 29, 1960 and abandoned at 3,244 feet by the end of the year. Co 1, located 25 miles northwest of Bissau, was drilled to 6,569 feet and plugged early this year. The third test, Cacongue 1 was then drilled to 8,613 feet and abandoned also.

Ivory Coast . . . test dry; new one slated

One dry hole was completed onshore on the Ivory Coast last year by SAP at Berou 1. It was spudded on November 3, 1959 and completed on April 10, 1960 at 13,448 feet at a location between Abidjan and the Ghana border. Some oil shows were logged. The well was believed to be in Albian-Aptian (Cretaceous) at bottom.

Plymouth Oil Co.-Benedum Trees interests withdrew from the Ivory Coast venture on April 14, 1960. SAP's permit, which expires August 28, 1963, included 2,233 square miles at the end of 1960. Additional wildcatting was expected in 1961.

Nigeria . . . production to expand in 1961

Prospects remain bright in Nigeria although 1960 drilling activity declined to 33 wells, chiefly because of oil transportation difficulties. In spite of reduced drilling, Shell-BP Petroleum Development Co. of Nigeria Ltd., the only producer in the country, boosted its 1959 production over 2 million barrels for a 1960 total of 6,289,684 barrels. Daily average production was 17,232 barrels.

The transportation difficulties now apparently hindering operations are expected to be solved by the end of 1961 with the completion of the Bomu-Bonny pipe line and new deep water tanker loading facilities at the mouth of the Bonny River. At that time, production is expected to increase to 60,000 bpd.

Another factor stimulating interest in the country is the 18,000 bpd capacity refinery scheduled for completion by Shell-BP near Port Harcourt in late 1963 or early 1964. Products from this installation are intended for the Nigerian market.

Drilling. Shell-BP remained the only successful oil finder in Nigeria during the past year. The company completed 12 successful oil discoveries out of 22 wildcats drilled for an enviable success ratio of 55 percent. Three additional tests were drilling ahead as of January 1961.

Development drilling resulted in completion of 6 oil wells and 1 gas well out of 9 attempts. Detailed production and development drilling statistics are included in Table 1.

Mobil Exploration Nigeria drilled two unsuccessful wildcat tests in 1960, and was drilling ahead on a third at year's end. Total 1960 footage drilled by the two operators was 355,291 feet.

In other exploration, Shell-BP, Tennessee Nigeria and Mobil Exploration Nigeria Inc. continued seismic work.

TABLE 1—Crude Oil Production, Producing Wells, and Development Drilling in Nigeria in 1960, by Fields

Source: Royal Dutch Shell semi-annual oil field statistical data.

Name of Field (or Area)	Ebubu	Oloibiri	Afam	Imo River	Bomu	Elelenwa	Bonny	Soku	Total[2]
Year of discovery	1958	1956	1957	1959	1958	1959	1959	1957	
Footage drilled in 1960	9,000			18,664	29,384	11,000		12,022	71,070
Total wells completed in 1960	1			2	4	1		1	9
(a) Oil wells	1			2	2			1	6
(b) Gas wells					1				1
(c) Dry holes					1	1			2
Wells drilling at end of 1960									
Suspended wells at end of 1960	1	2		2	1			1	7
Flowing wells at end of 1960	4	9	9	1	14	1	1		39
Pumping wells at end of 1960									
Wells drilled to end of 1960	5	16	13	3	17	2	2	2	60
Producing depths, feet	8,200-8,500	8,000-9,800	9,000-9,400		7,100-7,500	10,290-10,350	7,020-7,050	10,600-10,650	
Crude Production in 1960, bbls.	417,474	1,624,815	459,630		3,785,893		1,872		6,289,684
Crude production in Dec. 1960 bpd	2,747	4,911			12,695				20,353
Cumulative crude production to end of 1960, bbls.	1,173,782	4,333,111	2,196,430	84	4,296,113	23,026	2,077	22,206	12,046,829
Base of crude	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	Paraffin	
A.P.I. gravity of crude	26°-30° (27.5°)[1]	20°-29° (22°)[1]	36°-55° (43°)[1]	23°	32°-38° (35°)[1]	38°	30.5°	33°	
Age of producing formation	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene	

[1] Average API gravities. [2] Okoloma field data, reported in 1959 Statistics, was not produced or drilled in 1960.

Gabon . . . offshore wildcatting starts. Onshore production drop foreseen

OFFSHORE DRILLING was to commence next month as strong efforts are being made to augment and increase Gabon's oil reserves. Mobil International Oil Co., operator of the Gabon offshore permit, which is shared on a 50-50 percent interest basis with Societe des Petroles d'Afrique Equatoriale (SPAFE), was slated to start a 16-month offshore wildcatting program, utilizing a mobile jack-up type platform designed to operate in up to 100 feet of water. An earlier offshore seismic program indicated a number of favorable structures.

Concern is rising as to Gabon's oil reserves. SPAFE evidently expects a decline in crude oil output in 1961. The maximum 1961 yield projected by *Petrole Informations* is 800,000 tons (about 16,000 bpd), including the firm's 2,000-bpd output in Congo Republic. The 1960 crude yield in Gabon alone was 800,107 tons, or 5,856,175 barrels (see Table). Production thus averaged 16,000 barrels daily last year, 852 bpd or 5.6 percent more than the 1959 average of 15,148 bpd. Production during the first five months of 1961 averaged about 14,200 barrels daily.

Both development drilling and production in Tchengue field were highlighted last year, when 20 new wells, including 11 oil wells, were completed. Tchengue jumped from fifth to first place between 1959 and 1960 in crude oil yield, averaging 4,313 barrels daily from 19 flowing wells last year. The field was found in 1959. In contrast, M'Bega, Pt. Clairette-Port Gentil, Ozouri, Animba, and Alewana fields all declined last year.

Drilling continued to decline in 1960, with 35 completions aggregating 184,077 feet of hole, compared to 42 new wells and 192,981 feet of drilling in 1959. Nine of the 1960 completions were wildcats. Only 2 rigs were active at the end of 1960, and fewer than 10 completions had been recorded by mid-1961.

The following are additional development and exploration highlights in 1960:

- Northward extension of Pointe Clairette field. Well 36 was drilled to 5,185 feet and found 100 feet of upper Cretaceous oil sands.
- Rembo Kotto field, a 1959 discovery farther inland in the joint onshore SPAFE-Mobil area, was actively drilled last year. Four sand zones have been found productive in a limited-sized horst area. Maximum

Niger Republic... aeromagnetic work done

SOME RECONNAISSANCE oil exploration was done in this interior African nation, formerly part of French West Africa, lying between Nigeria on the south and the Algerian and Libyan Sahara on the north. About 12 crew weeks were spent in the field to finalize 23,000 line miles of aeromagnetic work completed during the past year. Fairchild Aerial Surveys, Inc. and an affiliated French exploration firm did this work.

Societe de Participations Petrolieres (PETROPAR) holds two tracts. The Talak permit borders Mali on the west and Algeria on the north and covers 26,000 square miles. It is for 5 years from September 7, 1960. The Djado permit covers 14,600 square miles along the Libyan border. It is also for 5 years, and was granted July 1, 1960. PREPA is the operator of the Djado permit and CEP will operate the Talak tract.

Spanish Guinea . . . search begins

SPANISH GULF OIL CORP. and Compania Espanola de Petroleos S A (CEPSA) jointly acquired about a quarter million acres in licenses and offshore rights last year and commenced geological and geophysical surveys. Included were surface geology, offshore seismic work, and aeromagnetics.

Crude Oil Production and Drilling in Gabon in 1960[1]

FIELD	Production 1960 Total Bbls.	Production 1960 Bbls. Daily	Production 1959 Bbls. Daily	Wells Producing At Year End: Flowing	Pumping	Total	Gas/Oil Ratios, Cu. Ft. U.S. Bbl. End of Year 1960	1959	Oil Gravity Deg. API	Age of Producing Formation	Producing Depths (Feet)	Wells Completed: Oil	Gas	Dry	Total	Footage Drilled (Feet)	Wells Drilled to End 1959	Wells Drilling Yr End
Tchengue	1,578,683	4,313	1,354	19		19	253	202	31.3	Mio.	3,800-4,300	11	...	9	20	93,846	36	...
M'Bega	1,424,848	3,893	4,846	17	1	18	359	202	27	L.E.[2]	3,350	...	...	...	...	.....	32	...
Point Clairette-Port Gentil	1,406,614	3,843	4,482	33	5	38	342	303	32.1	U.S.[3]	2,600-5,000	1	...	...	1	5,185	56	...
Cap Lopez	716,481	1,958	1,927	10		10	516	460	31.6	U.S.[3]	5,700	1	...	...	1	6,719	15	...
Ozouri	568,018	1,552	1,910	6	4	10	[4]	[4]	20.6	L.E.[2]	2,000-2,300	...	...	...	...	.....	17	...
Animba	132,511	362	374	3	1	4	...	...	13	L.E.[2]	1,700-1,800	...	...	...	...	.....	13	...
Alewana	21,096	58	255	...	1	1	...	...	33	C.R.[5]	2,900	...	...	...	...	.....	5	...
Batanga	5,698	16[6]	.....[6]	...	...	...	1,000	...	40	U.S.[3]	6,200-6,300	2	...	...	2	16,042	2	...
N'Tombenyoni	2,226	5[6]	.....[6]	...	...	...	735	...	41.5	U.S.[3]	5,000	1	...	...	1	4,989	...	...
Gongoue	.....	.....	.....	...	...	...	...	...	...	...	.....	...	...	1	1	5,394	2	...
Rembo Kotto	.....	.....	.....	...	...	...	...	...	47	C[7]	1,850-2,040	4	...	1	5	21,989	6	...
Sub-Total	5,856,175	16,000	15,148	88	12	100	.....	...	...	.....	.....	20	...	11	31	154,164	184	...
Other Wildcats	.....	.....	.....	...	...	...	...	...	...	.....	.....	1	...	3	4	29,913	4	...
Total, Gabon	5,856,175	16,000	15,148	88	12	100	.....	...	...	.....	1,700-5,700	21	...	14	35	184,077	188[8]	...
Total, 1959	5,529,203	15,148	15,148	80	18	98	.....	...	...	.....	.....	19	1	22	42	192,981	...	4

[1] Sources: SPAFE 1960 annual report and The American Association of Petroleum Geologists *Bulletin* 45, No. 7 (1961). [2] Lower Eocene. [3] Upper Senonian. [4] GOR negligible. [5] Cap rock. [6] 1960 discovery. [7] Cenomanian. [8] Excludes some wildcats drilled prior to 1960.

production found was 140 bpd. The field had not been produced as of last December.

• Gongoue field, located on the coast northeast of Port Gentil, was indicated by Gongoue 2 to be small. Gongoue 1 was completed early in 1958.

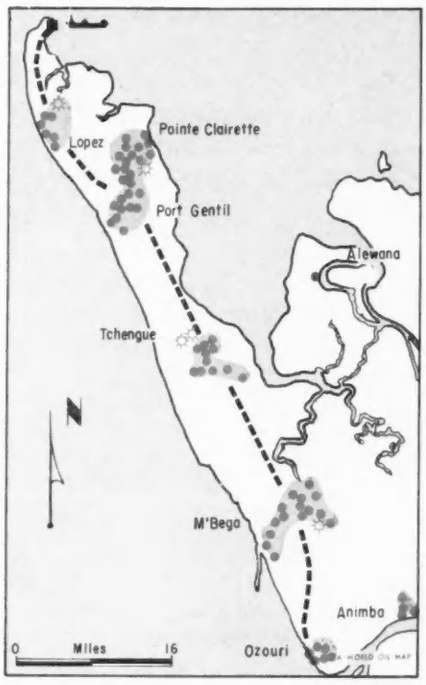
• N'Tombanyoni 1 well located a short distance southwest of Gongoue found 25 feet of oil sand in the upper Cretaceous on a seismic structure. Production tests indicated 84 bopd production on a ⅛-inch choke but pressure declined rapidly.

• Batanga 1, located on the base of the Gabon Peninsula found 125 feet of oil-bearing upper Senonian sand on the east flank of a salt dome. Batanga 2, a southeast extension, was completed in 1961 flowing 820 bopd. Total depth was 7,310 feet. However, Batanga 3, drilled to 8,543 feet, was abandoned on April 26.

• Assewe 1, located 10 miles south of Rembo Kotto and east of Batanga, was completed on a small closure for 24 bopd of 39.5° API gravity oil from four Turonian zones between 2,671 and 2,736 feet, according to AAPG *Bulletin* 45, No. 7 (1961).

In 1961, two additional wildcat oil strikes were made: one at SPAFE's Simany 1 near Port Gentil which flowed at the rate of 257 barrels daily from 3,460 feet, reportedly from lower Tertiary; and another wildcat, WZ 1, located near N'Tombenyoni

GABON'S PRODUCING FIELDS



and drilled by SPAFE-Mobil, was testing oil from three zones between 3,400 and 4,000 feet early in 1961.

Last October 24 Compagnie Shell de Recherche et d'Exploitation au Gabon (COSREG) received a 5-year permit covering an area south of the SPAFE-Mobil acreage and lying mostly south of Iguela, both onshore and offshore. COSREG is the operator and SPAFE has a 50 percent interest.

in the 100 percent SPAFE area as was the one test, Yangala YL 1, underway at the end of December. The six 1960 completions aggregated 31,633 feet of hole.

About 240 miles of onshore seismic profiles were shot last year in Congo in 9 crew months, including 3.5 in the south zone and 5.5 in the north. Seismic work continued in the north zone in early 1961.

Cabinda . . . deep tests expected this year

CABINDA GULF OIL CO. reported a vigorous stratigraphic drilling program in Cabinda in 1960, including a number of holes to potentially productive depths. Some shows were reported, but no producers were completed. There were 9 deep tests aggregating 39,667 feet of hole and averaging 4,407 feet in depth. Gulf also reported 59 structure holes aggregating 66,678 feet of drilling for an average of 1,130 feet per hole.

Surface geological, seismograph and gravity work augmented the drilling program which was to continue during 1961. Several deep tests were anticipated this year.

Congo Republic . . . lone oil field tapped

CRUDE OIL PRODUCTION started in the Congo Republic, formerly a part of French Equatorial Africa, in June 1960 in the nation's lone oil field, Pointe Indienne, near the coast. Output that month was 48,945 barrels, an average of 1,632 bpd. Cumulative crude oil production at the end of December was 388,023 barrels, an average of 1,060 bpd for the full year.

Crude yield during the first five months of 1961 at Pointe Indienne amounted to 316,850 barrels, an average of 2,098 bpd. Oil is moved from the field via 6-inch pipe line to a terminal at the mouth of the River Rouge and thence transferred into tankers through a submarine loading line extending offshore north of Pointe Noire.

SPAFE holds a 2,659-acre exploitation concession at Pointe Indienne. SPAFE likewise has 100 percent interest in an onshore coastal permit in Congo south of the Kouilou River, and jointly with Mobil holds the onshore coastal permit north of the Kouilou River in which SPAFE is the operator. Each group has a 50 percent interest in the offshore strip from the Cabinda border northward to Mayumba in Gabon, in which Mobil is operator.

Six deep tests were drilled in Congo in 1960, varying from 4,813 (Pt. Indienne 19) to 6,332 feet (Bas Kouilou BK 1 Ter.) The former was the only development well. It was completed for 75 barrels of oil daily. The wildcats were all dry. All the wells completed last year in Congo were drilled

Congo . . . oil is sought despite discord

DESPITE THE CHAOTIC POLITICAL situation following withdrawal of Belgium from the Congo, some oil exploration was conducted in 1960. Societe Congolaise de Recherches et d'Exploitation Petrolieres (SOCOREP) was formed in May 1960 by Petrobelge, Forminiere and several other firms to conduct oil exploration in the lower Congo concession. The original 1,700-square-mile grant included territorial waters of the Congo River from Banana to west of Boma to the coast, and north to the Cabinda border.

Exploration continued throughout 1960 and included 6 geological, 6 seismic and 5 gravity party months. The 2,620 gravity stations provided full coverage of 1,275 square miles including the portion covered by the Congo River.

Angola . . . all industry phases are on rise

STEADY PROGRESS continued to be made to develop Angola's oil industry in 1960 and 1961. Crude oil production last year from Benfica, Galinda, Luanda and Cacuaco fields amounted to 481,045 barrels as shown in the accompanying table. This was an average of 1,314 bpd, an increase of 33.9 percent compared to the 981 bpd rate of 1959. Exploration continued on the Companhia de Petroleos de Angola (Petroangol) concession. The operator is affiliated with Petrofina (Belgian interests).

Petrofina reported a total of 11 producing wells at the end of 1960, all flowing. There were 12 flowing wells and 2 pumpers on production at the end of 1959.

According to AAPG *Bulletin* 45, No. 7 (1961), about 20 wells are expected to be drilled in Angola's Cuanza Basin this year, where all the existing production is located. Seismic studies were made last year to clarify interpretation of previous coverage. Drilling continued with 4 rigs (3 medium and 1 heavy). Petrofina reported two wildcats drilling at the end of 1960, Banvo 1 and Morro Liso 1. An oil well was completed in the Galinda field in the Binga formation (lower Cretaceous). Previously reported production at Galinda was in Aptian limestone.

Wildcat completions in 1960 reported in the *Bulletin* ranged in depth from 5,454 feet (Pitchi 1) to 11,833 feet (Tuenza 1).

Crude Oil Production in Angola in 1960
Sources: Petrofina, and AAPG Bulletin 45, No. 7 (1961)

Company and Field	PRODUCTION		*Wells Drilled to End 1960
	Total Barrels	Bbls. Daily	
Petrangol	355,756	972	29
Benfica	275,637	753	15
Luanda	80,119	219	14
Petrofina	125,289	342	11
Cacuaco	39,826	109	6
Galinda	85,463	233	4
Bom Jesus	.....	.....	1
Total	481,045	1,314	40
Total, 1959	357,983	981	..

* Discovery wells plus field development wells. Excludes dry wildcats outside areas specified.

Petrofina reported completion of 3 development wells last year, 1 oil well and 2 dry holes, aggregating 20,902 feet; also, 12 wildcats aggregating 140,458 feet of hole. Good shows were found in Banvo 1, located about 28 miles south of Galinda field. Oil shows were also reported in Funda 1, Uacongo 3, Tuenza 1 and Tobias 1.

During the past two years a 3-inch pipe line between Cacuaco field and the Luanda refinery and a 3 and 4-inch line from Galinda field to the Benfica tank farm have been completed. Bom Jesus field has also been connected by pipe line with Petroangol's Luanda refinery.

The Luanda refinery has been expanded to 4,000 bpd capacity. An average of 3,600 bpd was charged last year. New proposals have been made to boost topping capacity at Luanda to 10,000 bpd.

S. W. Africa . . . exploration under way

MORE SERIOUS INTEREST was shown in South West Africa's oil possibilities in 1960 and early 1961. Important developments were:

- Granting of a 90,000-square-mile concession in the extreme north to Etosha Petroleum Co., a wholly-owned subsidiary of Texas Eastern Transmission Corp.
- Nine party-months of surface geological work was done in 1960 by Standard-Vacuum Oil Co., working the stratigraphy of the Karroo series in South West Africa, Union of South Africa, and Bechuanaland. Oil prospects were described as neither highly favorable nor unfavorable, pursuant to a survey of these unusual facies.
- The joint geological work reported in 1961 between Stanvac and the Artnell Company of Chicago to explore Artnell's Orth-duPlessis concessions on the coast near Walvis Bay and farther inland east of Luderitz. Artnell was interested in diamonds and metallic minerals as well as in oil and gas.
- The Territorial Government was stiffening terms for concessions, to eliminate promoters in favor of bona fide oil operators. Some former permits expired and were not renewed; also, a 10 percent royalty is to be required in the future compared to none in the past.

Etosha's 56-million-acre concession lies between 20 degrees South latitude and the Angola border and between 21 degrees East longitude and the Atlantic Ocean. Preliminary geological reconnaissance indicates marine sediments in much of the area. A contract for a detailed aerial magnetic survey was awarded to Hunting Surveys, Ltd. of London, England. Further geophysical work and stratigraphic drilling were expected to be done later.

Trans-American Mining Corp. continued exploring its Diamond No. 2 concession on the coast between Luderitz and Walvis Bay last year. Reportedly the firm's next phase will be seismic work followed by core drilling.

Conorada Petroleum Corp., formerly a participant in reconnaissance oil exploration in the general South African area, has dropped out.

Stanvac's interests in South and South West Africa will revert solely to Mobil Petroleum Co., Inc. when the split-up of Stanvac between its two parent firms is completed.

South Africa... geological work done

STANDARD-VACUUM OIL COMPANY did geological reconnaissance in Karroo system areas in the Union of South Africa in the Cape Province, Natal and the Orange Free State last year, in connection with similar work already mentioned in contiguous areas in South West Africa.

A few 1,000-foot test holes were drilled in Table Mountain quartzite (Siluro-Devonian) in the Humansdorp Division of Cape Province, according to AAPG *Bulletin* 45, No. 7 (1961). Zitzikamma Olie Sindikaat, whose prospecting license was renewed, did this work. No oil was found.

Madagascar... exploration proceeds, as oil search is challenge

EXPLORATION IS CONTINUING, but drilling was suspended at the start of 1961 in the 56,000-square-mile permit covering the Morondava Basin on the southwest side of the island of Madagascar. The operator is Societe des Petroles de Madagascar (SPM). Many shows, intricate structures (including some horsts), and rapid facies changes make the oil search challenging but thus far unrewarding.

SPM's permit was renewed for five years in September 1960 by the Malagasy Republic, which now comprises and governs Madagascar. The 1961 program calls for a complete study and re-evaluation of stratigraphic and palynologic data. Emphasis will also be placed on possible exploitation of the Bemolanga bituminous sandstones. Some attention will likely be paid to the Majunga Basin, located on the northwest part of the island, most of its outside of SPM's permit with the exception of the southernmost portion.

Six wells were completed in Madagascar last year, five of them between Miandrivazo and Cape St. Andre in the northern part of the permit in or near the Majunga Basin. Two of the wells had been spudded in 1959. Actual amount of hole drilled in 1960 was 25,764 feet. The six dry holes finished in 1960 are listed thus:

Well	Total depth (feet)
Vohidolo 2 bis	11,238
Belinta 2	8,245
Belinta 3	3,941
Maroaboaly 1	6,515
Cape St. Andre 1	5,473
Cape St. Andre 2	7,064
Sum of total depths	42,476

These data on Madagascar are adapted from *Petrole Informations* and AAPG *Bulletin* 45, No. 7 (1961).

Mozambique... more wildcat tests expected to be drilled in 1961

EXPLORATORY DRILLING was expected to start anew in Mozambique in 1961. A 40-year, 29.35-million-acre concession is held jointly by Mozambique Pan American Oil Co. and Mozambique Gulf Oil Co. (Mozgoc), with the latter serving as operator. Five dry wildcats were drilled on Gulf's old concession, which expired in 1958.

Surface geological, seismograph, gravity, and ground magnetic work was conducted last year on this acreage with encouraging results.

Mozambique's first refinery was being built at Lourenco Marques by Sociedad Nacional de Refinacao de Petroles (SONAREP). Slated for 1961 completion, this plant is expected to charge 12,000 bpd of crude oil initially.

Tanganyika... surface geological surveys conducted in two areas

EXPLORATION CONTINUED in Tanganyika last year, as BP-Shell Petroleum Development Co. of Tanganyika Ltd. conducted 3½ months of surface geological work. These surveys were in the Ruvuma area, along the Mozambique border and in the Ngude area west of Dar-es-Salaam. No drilling has been done since Mandawa 7 was abandoned early in 1959. The rig was stacked at Dar-es-Salaam, and geophysical crews were transferred to Kenya.

Reportedly, a proposal has recently been made to the Tanganyika government by Stanvac and Caltex to build a small refinery to fulfill local product needs.

Kenya... Third test started in active stratigraphic drilling program

BP-SHELL PETROLEUM DEVELOPMENT CO. OF KENYA LTD. commenced a vigorous stratigraphic drilling program in the Lamu embayment area of Kenya late last year. Walu 1, near the Tana River a few miles from Galole, was drilled to 5,800 feet to begin the new program. A second test, Pandangua 1, was drilled to 6,500 feet (total depth) by the end of December. The mobile stratigraphic rig was being moved to a new location at the beginning of 1961. A third test was reported drilling early this year.

BP-Shell has a 35,000-square-mile coastal concession in Kenya northward from the Tana River to the Somali border. Aeromagnetic surveys have been completed and are being followed up with gravity and reflection seismic work. Late in 1960 seismic work was under way between Lamu and Wajir. In October this work was being done north of Lamu near the Somali border. Coverage was at the rate of about 100 miles a month.

According to AAPG *Bulletin* 45, No. 7 (1961), Frobisher Ltd. did some geological work in its 8,000-square-mile concession inland to the northeast bordering Somali; also, N. M. Mehta continued geological exploration of his license in southeast Kenya and acquired a new license in January 1961 over part of the previous area and some new acreage south of it.

Somali... small but non-commercial amounts of oil and gas are discovered in wildcat by Sinclair

SINCE LAST YEAR'S report (WORLD OIL, August 15, 1960, Page 176) was written, two former colonies of European nations have merged to become the Somali Republic. Somalia, a former Italian territory under United Nations trusteeship, and the Somaliland Protectorate, which more recently became wholly independent of Great Britain, jointly comprise Somali. All acreage has recently been dropped by oil companies exploring in the former Somaliland Protectorate, but some encouragement has recently been noted in the region formerly called Somalia.

The main encouraging event as of mid-1961 in Somali was the finding of small though non-commercial amounts of oil and gas in Sinclair Somal Corp.'s Coriole 1 wildcat, located on a large concession which covers all of the Indian Ocean coastal strip except the one near the north tip held by Mineraria. Coriole 1 is located about 30 miles inland, and 50 miles west of Mogadiscio. Somal's oil was thought to be about 35° API gravity and to have occurred in Tertiary strata.

Sinclair announced the oil show at Coriole 1 on February 7, 1961, and expressed intention of drilling deeper. The well has since been abandoned.

In 1960 Somal drilled a deep dry hole, Duddumai 1, to 11,080 feet, about 45 miles northwest of Mogadiscio. A new area of 9,408,000 acres was added to Sinclair Somal's concessions, solidifying them along the coast to the Kenya border. One seismic crew worked the entire year.

Frobisher Ltd. holds 70,000 miles in Somali, inland from Sinclair Somal's area, and contiguous with the Frobisher Kenya license. Gravity and reconnaissance geological surveys conducted last year were slated for completion in 1961.

Near the northeast tip of Somalia, Mineraria Somala (Italian interests) completed a dry hole, Hordio 1 at 11,200 feet near Ras Hafun in May 1960. Considerable geologic work has been done by Mineraria and is continuing.

The Somali coastal section is said to be similar to southern Arabia's with the exception of certain unfavorable facies changes, including a thick, massive Jurassic limestone section with no evaporites found so far.

Standard-Vacuum Oil Co. completed its final wildcat in the Somaliland Protectorate area, Biyo Dader 1 at 4,842 feet on February 2, 1960, and dropped its concession. Stanvac is continuing geological and geophysical work in its 11,740-square-mile concession in the former Somalia territory between Sinclair Somal's coastal areas and the Ethiopian border. An aerial photographic survey was completed early in 1960. The company has applied for some new acreage southwest of its concession. Stanvac's split-up will cause its exploration interests in Somali to revert to Mobil Petroleum Co., Inc. with Esso Standard Eastern, Inc. reserving the right to receive 50 percent participation.

BP Exploration Co. Ltd. completed the last well in a stratigraphic drilling program in the Somaliland Protectorate area, Zeila 4 at 1,419 feet last year. Three similar holes were completed in 1959. All BP's licenses and applications were surrendered on October 15, 1960. Before that, the company conducted the following numbers of crew-months of geological and geophysical work: surface geology, 3½; marine seismic reflection, 1½; and stratigraphic drilling, 3.

Ethiopia...

Ogaden acreage is worked

GEWERKSCHAFT ELWERATH has conducted geological and geophysical surveys in its concession area in Ogaden Province, Ethiopia. Much of the work done so far by Elwerath was conducted in 1959. Under the concession's terms half of the area was to revert to the government after March 1961 and another quarter of it in 1963.

Russia reportedly lost its right to build a refinery in Ethiopia when the Emperor decided against dependence on imported Soviet crude. It was also reported that he engaged a U. S. oilman as petroleum advisor.

Sudan... seismic surveys scheduled to be continued in 1961, and drilling of wildcat planned

AGIP MINERARIA (SUDAN), Sudanese affiliate of the Italian Ente Nazionale Idrocarburi (ENI) was active in exploration in Sudan on its 3,300-square-mile concession acquired in August 1959, along the Red Sea coast and offshore. AGIP's acreage consists of 11 permits of about 800 square kilometers (about 317 square miles) each, 3 of them near Muhammad Qol and 8 on the coast south of Port Sudan. Geological and geophysical work started in September 1959. Some aerial photographic, surface geologic, gravimetric and seismic coverage has been achieved, including some offshore seismic work. In 1961 the seismic surveys were to be continued and a wildcat well was proposed.

General Exploration Co. (Sudan) Ltd. (U. S. interests) obtained 7 licenses during the fall of 1959 adjoining AGIP's. General's holdings aggregate about 2,160 square miles. Preliminary geophysical surveys have been done.

Shell of Sudan also received an exploration permit in 1959, covering 1,930 square miles in the northwest.

The Italian ENI group has proposed an 8,000 bpd refinery project to meet Sudan's domestic products requirements. The Shell group and British Petroleum Co. Ltd. were invited by the Sudan government to submit a joint counterproposal for construction of a refinery.

Egypt Region of UAR . . . development of new fields pushed to offset depletion

EGYPT'S OIL PICTURE, like Iraq's, was a mixture of encouragement and uncertainty as of mid-1961. Offshore drilling was underway in the Gulf of Suez on the north Belayim concession of Compagnie Oriental des Petroles d'Egypt (COPE) in early 1961. An important offshore discovery or new pay extension to Belayim field was reported in 1961, initially flowing 1,900 barrels of 31° API gravity oil daily. Active drilling both on and offshore continued in the Suez Graben area, with about 10 drilling rigs busy at the start of 1961. Fifty-three wells were completed last year, and more than 60 were expected to be finished in 1961.

In the Western Desert, the government was considering bids for exploration licenses from Pan American International Petroleum Corp. and from Royal Dutch Shell. An offer from Italy's ENI to explore for oil in the Western Desert was reported also.

Whereas Shell and Pan American were considering entering Egypt in 1961, the Belgian firm Petrofina sold out its participation in COPE because of political circumstances and withdrew.

Crude oil production increased last year by 5.6 percent to 22,559,182 barrels (Table 1), an average of 61,637 barrels daily compared to the 58,372 bpd rate of 1959. The government-owned General Petroleum Company of Egypt's new production at Bakr and K'reim commenced last year and was instrumental in boosting crude oil output above the 1959 yield. However, it was not known how commercial these fields would be. The original data developed by private interests on which General's development was initially based indicate rather marginal prospects, and the 17 to 23° API gravity range of Bakr and K'reim crudes does little to balance Egypt's preponderance of heavy crudes and dearth of light domestic oils. However, 22 new producers were completed at Bakr last year, according to AAPG *Bulletin* 45, No. 7 (1961). K'reim has already been found to be complexly faulted.

Increases in crude yields were recorded last year at Belayim, Hurghada, Sudr, Asl and Ras Matarma fields. These gains were almost offset by somewhat depleted outputs at Abu Rudeis, Feiran and Ras Gharib. Abu Rudeis suffered a 25.1 percent decrease from 7,861 bpd in 1959 to 5,888 bpd in 1960 despite completion of the important Sidri south extension.

Drilling was more active in Egypt than in previous recent years. The 53 completions in 1960 included 43 development wells and 1 wildcat completed for oil, and 4 development wells and 5 wildcats abandoned as dry. The 223,559 feet of development and 53,458 feet of exploratory hole amounted to a total of 277,017 feet. These figures all compare favorably with 29 oil wells, 2 dry holes, and 184,964 feet of hole drilled in 1959.

The mobile offshore platform "Scarabeo" operated by the Italian SAIPEM group was drilling to develop the north Belayim extension in 1961.

According to the AAPG *Buletin* 45, No. 7, (1961), General Petroleum completed a discovery at Rahmi 1 on December 7. Total depth was 7,514 feet in Senonian. Completion was in lower Miocene and Eocene for 145 bpd on pump. Rahmi is on the west side of the Suez Gulf about 17 miles north-northwest of Bakr. Pay zone was reported at 4,500 feet.

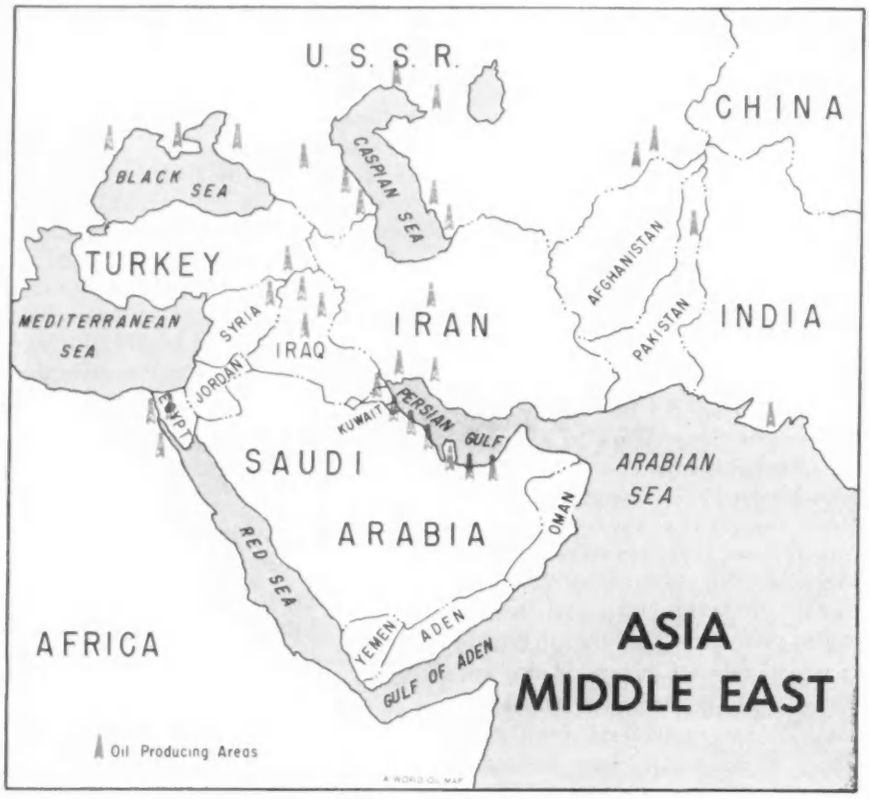
In other exploration, seismic and gravity crews worked the Eastern Desert and western and northern Sinai. Stress was placed on the Suez Gulf area where two seismic parties were active. However, there was much less geophysical work done in Egypt in 1960 than in 1959.

TABLE 1—Crude Oil Production and Development Drilling in Egypt in 1960, by Companies and Fields

Sources: Royal Dutch Shell semi-annual statistics; the American Association of Petroleum Geologists *Bulletin* 45, No. 7 (1961); and other private sources.

COMPANY and FIELD	CRUDE OIL PRODUCTION: Total Barrels 1960	Total Barrels 1959	Barrels Daily 1960	Barrels Daily 1959	Percent Diff.	Year Discovered	Total Wells Drilled to Yr. End	Producing Formation	Oil Gravity (deg. API)	WELLS COMPLETED: WELLS Oil	Dry	Total	Total Footage	Wells Drilling Yr. End
Compagnie Oriental des Petroles d'Egypt (COPE)	12,713,024	12,391,233	34,735	33,949	2.3	....	82	.....	.....	12	3	15	119,620	5
Belayim	10,464,184	9,410,465	28,591	25,782	10.9	1955	62	middle Miocene	22–23	10	2	12	87,967	1
Abu Rudeis-Sidri	2,155,084	2,869,023	5,888	7,861	—25.1	1957	15	basal Miocene	22	2	1	3	31,653	3
Feiran	93,756	111,745	256	306	—16.4	1949	5	middle Miocene	26	..	..	..	.....[1]	1
Anglo-Egyptian Oilfields Ltd.[2]	6,358,497	6,666,754	17,373	18,265	— 4.9	....	314	.....	.....	2	..	2	2,920	..
Ras Gharib	6,129,762	6,441,076	16,748	17,647	— 5.1	1938	175[3]	[4]	25–27	2	..	2	2,920	..
Hurghada	228,735	225,678	625	618	1.1	1913	139[3]	[5]	22–30	..	..	..	.....	..
Anglo-Egyptian Oilfields Ltd.[2] and Mobil Oil Egypt Co.	2,309,123	2,247,755	6,309	6,158	2.5	....	69	.....	.....	1	..	1	3,000	..
Sudr	1,133,994	1,103,130	3,098	3,022	2.5	1946	34[3]	[6]	22–23	1	..	1	3,000	..
Asl	1,072,868	1,046,642	2,931	2,868	2.2	1948	29[3]	[6]	22–23	..	..	..	.....	..
Ras Matarma	102,261	97,983	280	268	4.5	1948	6[3]	[7]	17–18	..	..	..	.....	..
General Petroleum Company	1,178,538	.....	3,220	.....[8]	.....	....	49	.....	.....	28	1	29	98,019	3
Bakr	1,134,741[8]	.....[8]	3,100[8]	.....[8]	.....	1958	38	Eocene, Cret.	22–23	22	1	23	85,267	2
K'reim	43,797[8]	.....[8]	120[8]	.....	.....	1958	11	Eo., basal Mio.	17–18	6	..	6	12,752	1
Total, Egypt	22,559,182	21,305,742	61,637	58,372	5.6	.....	514	.....	.....	43	4	47	223,559	8
Total, 1959	.....	.....	.....	.....	.....	.....	.....	.....	.....	29	1	30	169,844	10

[1] 8,195 feet of hole drilled at Feiran in 1960 not included since no wells were completed. [2] Anglo-Egyptian Oilfields Ltd.'s properties were "sequestered" in 1957 and run by the Egyptian government until mid-1959. [3] Oil wells completed in AEO's fields as of 12-31-60 include 165 at Ras Gharib, 107 at Hurghada, 18 at Sudr, 9 at Asl, and 3 at Ras Matarma: Total, 302. [4] Carboniferous, Cretaceous sands and Miocene limestone. [5] Carboniferous, Cretaceous sands and Miocene conglomerate. [6] Eocene limestone, Miocene sand and limestone. [7] Eocene limestone and mid-Miocene limestone. [8] 1960 was first year Bakr and K'reim fields on commercial production.



Syria Region of UAR... Commercial oil production planned, as drilling proceeds

EXPLORATION AND DEVELOPMENT continued in Syria as plans were being made to exploit oil fields found in recent years in the extreme northeast.

Concordia S A R L, affiliated with Deutsche Erdol-Aktiengesellschaft of Hamburg, West Germany, continued wildcatting last year, and confirmed its Souedie oil discovery between Karatchok field and the Iraq border. In March 1961 Concordia obtained a four-year renewal of its exploration rights covering a reduced portion of its original Syrian holdings.

Concordia completed three wells in 1960, including a dry wildcat Toueman 1, located about 100 miles southwest of Souedie field, at total depth 8,066 feet in upper Paleozoic. Tschembe 1, another dry wildcat about midway between Toueman 1 and Souedie, was drilled to 9,600 feet in lower Cretaceous. The confirmation test Souedie 2 was drilled to 9,511 feet in Jurassic and completed for oil. Total footage of these 1960 completions was 27,177 feet. Souedie 3 was drilling at the end of December.

By mid-1961 Concordia had three productive oil wells at Souedie. Most of the reserves established were described as comprised by heavy oil, with lesser amounts of lighter crude. Consideration was being given to linking Karatchok and Souedie fields either with a pipe line to the Mediterranean coast or to the Homs refinery.

Karatchok development. While Atlantic Refining Co. and MenHall Prospecting and Exploitation Co. made efforts via the U.S. State Department to acquire compensation for the expropriated Karatchok field and other investments in Syria, the U A R government made plans for development and exploitation. Early in 1961 the Syrian Region General Petroleum Authority invited bids for drilling 20 oil wells and 3 gas wells. The tender visualized 17 development wells and 3 wildcats ranging between 6,500 and 11,500 feet deep at Karatchok and 3 tests in the Jezirah area expected to be completed for gas between 2,000 and 5,300 feet of depth.

U A R government sources have shown considerable optimism as to the oil potential of Karatchok field and northeast Syria generally, and have also indicated the intention to use a number of Russian rigs in vigorous exploration and development programs.

The Karatchok structure is large, but its reserves may not be sufficient to justify big capital outlays. Karatchok crude is about 22° API gravity, highly viscous and sour. The pay is a limestone; porosity is provided by fractures; and reservoir pressure is low. Whether the U A R government will allocate sufficient funds for northeastern Syrian oil or instead will concentrate on the Egyptian Region appeared to be a vital question as of mid-1961. The report that payments for crude delivered to the Homs refinery were in default (PETROLEUM REFINER, September 1960, Page 383) may be indicative of the Syrian Region's chances of receiving adequate appropriations for oil field development.

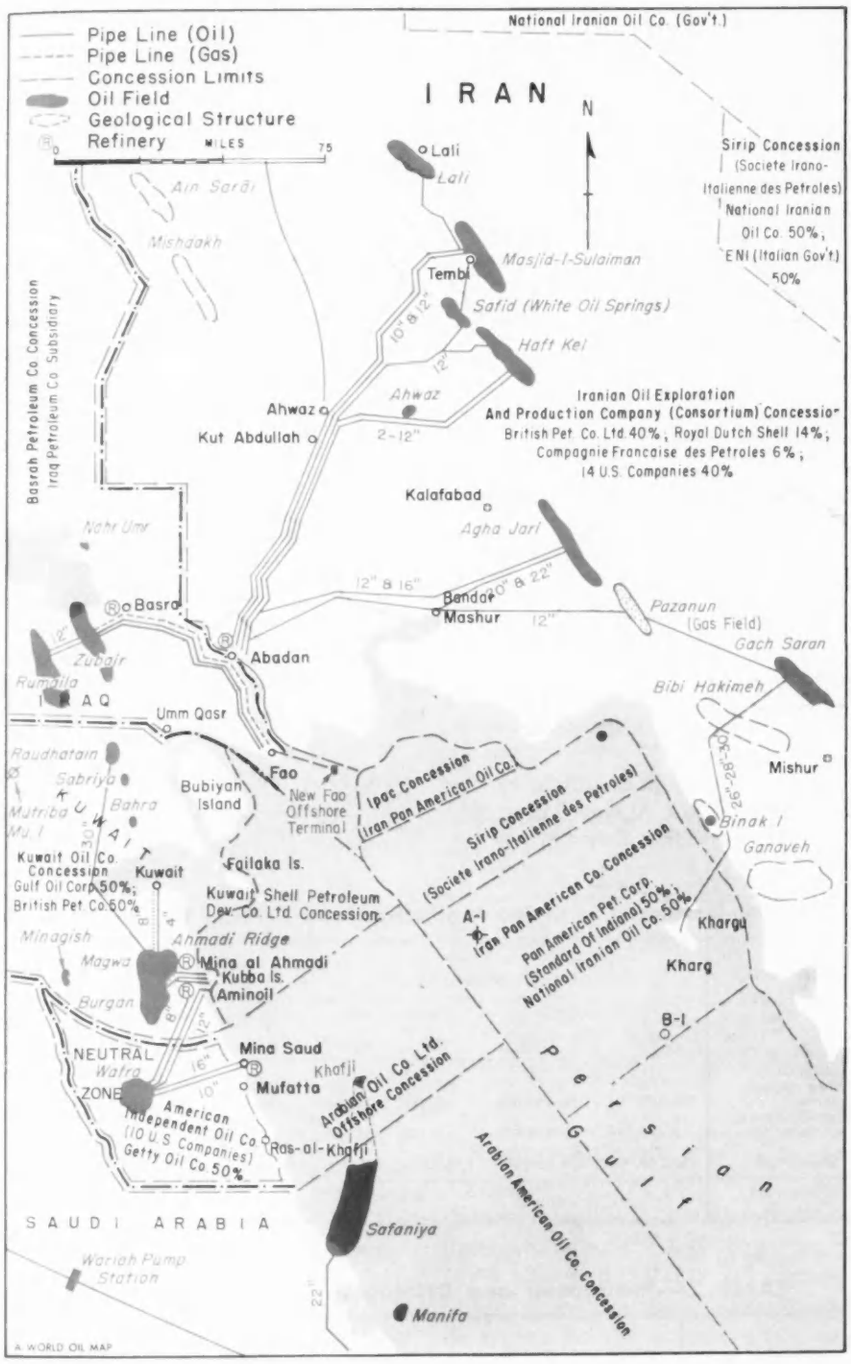
Yemen... first wildcat spudded

YEMEN'S FIRST WILDCAT well was spudded on July 19, 1961, near Salif on a peninsula on the Red Sea coast by John W. Mecom, independent operator of Houston, Texas. This well is projected to 5,000 feet. A second well was to spud before August 15 in the Zeidiye area, 40 miles east of Salif, and be drilled to 10,000 feet.

Mecom has the same 10,000-square-mile concession area covering the Red Sea coastal plain and offshore waters previously acquired by W. Angie Smith III in the name of American Overseas Investment Co. Smith is now working for Mecom, who obtained his rights on February 1, 1961. Mecom's concession carries a 5-year exploration period and a 30-year development term.

Surface reconnaissance indicated a major outcropping salt dome in the Salif area. Geophysical work, including gravity coverage, has provided several drilling prospects. Four rigs and other exploration equipment were

UPPER PERSIAN GULF



Offshore developments highlighted 1960-1961 activity in the northern Persian Gulf area. Both Khafji field in the Neutral Zone and Safaniya field in Saudi Arabia were greatly extended. It appeared possible that they might eventually merge. A Shell group member received offshore rights in Kuwait and began exploration. In Iraq, the new Fao offshore terminal was being completed in 1961. In Iran, SIRIP discovered oil in its first well and IPAC tested oil shows in its initial two offshore wells. The important new Kharg Island pipe line and terminal system entered service in August 1960.

shipped from Houston and arrived in Yemen in June. Mecom's Yemen headquarters are at Salif.

Though other competent oil people (Deilmann—West German interests) have had this Tehama coastal strip concession area in the past, Mecom is the first to drill it.

Bahrain... Output steady at 45,000 bpd

CRUDE OIL in Bahrain is being produced at a remarkably stable rate of 45,000 bpd and processed in the local Sitka refinery. The crude yield in 1960 amounted to 16,500,424 barrels, an average of 45,083 bpd, almost identical to the 45,132 average of 1959. The increased total last year was due to the additional producing day in February. Average crude oil production during the first five months of 1961 was 45,052 bpd.

Production of the 33° API gravity crude is from 150 wells, all flowing from the Jurassic-Cretaceous pay zone at about 2,600 feet. Five other wells produce gas from the Permian at about 11,000 feet for injection for pressure maintenance in the oil-bearing formation.

Drilling. Only one development well was completed last year. The Fasht

TABLE 1—Production and Drilling in Bahrain, by Years

Year	Crude Oil Production		Wells Completed				
	Barrels	Barrels Daily	Oil	Gas	Dry	Total Wells	Total Footage
1960	16,500,424	45,083	1	..	..	1	3,000*
1959	16,473,378	45,132	..	..	1	1	7,675
1958	14,873,111	40,748	2	..	1	3	5,535

* Estimated.

TABLE 2—Production Wells in Bahrain in 1960

OIL WELLS				GAS WELLS			Total Wells Producing	Total Wells Shut In
Flowing	Pumping	Shut In	Total	Flowing	Shut In	Total		
150	....	4	154	5	...	5	155	4

TABLE 3—Crude Oil Production in Bahrain in 1961, by Months

MONTH	Barrels	Barrels Daily
1961:		
January	1,398,061	45,099
February	1,260,569	45,020
March	1,397,610	45,084
April	1,351,165	45,038
May	1,395,503	45,016
Total, 5 Months	6,802,908	45,052

BAHRAIN

al-Jarim wildcat on a shoal north of Bahrain Island, 15 miles from Manana was spudded in October and was drilling at the end of December. This test was abandoned below 12,000 feet in 1961. Both Bahrain and Arab zones were non-productive.

Refining. Crude oil and other feedstocks processed at the Sitka refinery averaged about 208,000 bpd in 1960, representing capacity runs second only to the plant's record average thruput set in 1954.

New facility. Bahrain Petroleum Co. (Bapco), holder of the Bahrain concession, is building a new island wharf which is scheduled to enter operation early in 1962. Seventeen product lines of up to 14-inch diameter were to be laid to the new terminal.

Iran... Exploration pays off both onshore and offshore. Oil is confirmed at Ahwaz

IMPORTANT STRIDES continued to be made by Iran's oil industry in 1960 and early 1961. Some important highlights were

- Production of more than a million barrels of crude oil daily in 1960. Last year's daily average was 1,067,636 barrels, 139,390 bpd or 15 percent more than the 1959 average of 928,246 barrels
- Completion of the new Kharg Island terminal in the Persian Gulf
- Discovery of offshore oil at the head of the Gulf
- Confirmation of the Ahwaz oil discovery
- Finding of oil early in 1961 on the Pazanun structure, previously known to be gas-bearing only.

Consortium activity. Iranian Oil Exploration and Producing Co. (IOEPC) operates the south Iran concession area on behalf of the Iranian government, and for 14 U.S. companies, British Petroleum Co. Ltd., Royal Dutch Shell and Compagnie Francaise des Petroles, a private group known generally as the Consortium. IOEPC boosted production to 388,383,904 barrels (1,061,158 bpd) in 1960 (Table 1), representing a more than 14 percent boost above the 1959 rate (Table 2).

Agha Jari continued to lead other Iranian fields in 1960 when production was increased to 668,621 bpd with 32 wells flowing at the end of December. Haft Kel was in second place with more than 100,000 bpd last year, but Gachsaran is expected to overtake Haft Kel this year now that the 26/30-inch pipe line to the Kharg Island terminal has entered service. December 1960 production at Gachsaran averaged 209,000 barrels daily. Gachsaran is Iran's biggest oil field.

A new monthly record was set last October, when average net production was 1,202,000 bpd. This record was being exceeded in 1961; in May the average crude production was 1,273,000 bpd. Average production during the first five months of 1961 was 1,137,378 bpd.

Ahwaz field went on production at the start of 1960. Ahwaz 6 produced an average of 6,032 bpd. On April 8, 1961, IOEPC announced that Ahwaz 8 flowed oil and gas at 8,500 feet with 470 feet of the Asmari formation penetrated. On May 8, Ahwaz 8 began producing 26,000 barrels of oil daily, augmenting the 6,800-bpd production from Ahwaz 6.

In the older fields (Masjid-i-Sulaiman and Naft Safid) some gas lift facilities were installed to help maintain production rates.

Active drilling continued in south Iran throughout 1960 and early 1961. Eight drilling rigs, including 5 on development and 3 (including a new one added at the start of 1960) assigned to exploration, worked in the Consortium area last year, and one light workover rig was employed also. IOEPC completed 7 oil wells, 1 dry hole, and 3 observation wells, and drilled 106,494 feet of hole. This footage included 40,490 in exploration, 63,437 in development and 2,567 in servicing work.

Three rigs drilled at Gachsaran field last year, where 6 new wells and 1 workover were completed. Two good producers potentialed a total of 60,000 bpd, and two smaller ones were completed for 5,000 bpd each. Two reservoir observation wells were also completed. Gachsaran productive

TABLE 1—Summary of Crude Production and Drilling in Iran in 1960

AREA	CRUDE OIL PRODUCTION: Total Barrels 1960	Total Barrels 1959	Barrels Daily 1960	Barrels Daily 1959	WELLS: Producing, Yr. End	Completed: Wells	Completed: Footage	Drilling, Yr. End
Consortium Area (South Iran)	388,383,904	336,895,000	1,061,158	923,000	109	11	106,494	4
Outside Consortium Area	2,370,996	1,914,853	6,478	5,246	3	9	88,897	4
Total, Iran	390,754,900	338,809,853	1,067,636	928,246	112	20	195,391	8
Total, 1959					93	16	173,641	13

TABLE 2—Production and Drilling in South Iran in 1960

FIELD	Wells at End of Year: Total	Producing	Drilling	Wells Completed: Workovers	New Wells	Crude Oil Production: Barrels Daily	Total Barrels	% Rise
Agha Jari	51	32	...	1	3	668,621	244,715,303	11.6
Haft Kel	48	20	...	...	...	162,475	59,466,075	8.3
Gachsaran	30	10	2	1	6	109,814	40,191,981	86.1
Masjid-i-Sulaiman	257	27	...	12	...	60,394	22,104,065	34.2
Naft Safid	29	15	...	7	...	40,932	14,981,204	—25.6
Lali	15	4	...	...	...	12,890	4,717,566	—14.1
Ahwaz	7	1[1]	...	...	...	6,032	2,207,710	....[1]
Binak	1	...	...	...	1	...	...	...
Mand	2	...	...	...	1	...	...	...
Pazanan	5	...	1	2	...	...	...	...
Total, Iran	445	109	4[2]	23	11	1,061,158	388,383,904	14.3
Total, 1959	428	120	7	3	11	923,000	336,895,000	12.4

[1] Production began at Ahwaz in 1960. [2] Includes Bandar Abbas wildcat, later abandoned.

units 1 and 2, with necessary H_2S stripping facilities installed, have capacities of 140,000 and 150,000 bpd respectively.

At Agha Jari, three new wells were completed, two for an aggregate potential of 55,000 bpd, and the third as an observation well.

In exploratory drilling, Mand 2, on the south coast near Bushehr, was drilled to 13,541 feet without commercial oil being found, and abandoned. Suru 1 near Bandar Abbas in the extreme south was drilled to 14,509 feet by the end of December. Gas shows were found in the lower Cretaceous at about 11,400 feet. The well was later reported abandoned at 14,895 feet.

On the Pazanun structure, well 5 was started in March 1960 but had to be abandoned for mechanical reasons in September. Pazanun 5A was then drilled and by March 1961 had proved an oil column to exist in this gas field.

By mid-1961 Bibi Hakimeh 1, a wildcat between Gachsaran and the coast, and Lavan 1, located on Sheykh Shu'eyb Island in the southern part of the agreement area were both being drilled. A deep test at Gachsaran (well 36) was also underway.

The 1959 wildcat discovery, Binak 1 on the Kuh-i-Bang structure northwest of Ganaveh will require additional drilling before it is known whether commercial amounts of oil are there.

In other exploration, 3 seismic, 1 gravity, 2 geological, and 2 topographic-geodetic parties have been working in various areas in south Iran. A marine gravity party provided coverage in the Qeshm and Sheykh Shu'eyb islands. Refraction seismic work was done to determine the northwest and southeast ends of Gachsaran oil field, to outline the neighboring Garangan-Chilingar structure, and to evaluate the Bibi Hakimeh prospect. Reflection seismic was conducted in the plains between Ahwaz and Abadan, over the Ahwaz oil field, and in the coastal plain. Marine seismic work was done all along the coast from Qeshm Island northwest to Kharg.

One geologic party mapped coastal areas in Fars Province. A geodetic party helped provide basic control in Fars.

New terminal. The Gachsaran-Kharg Island pipe line system entered service in August 1960.

TABLE 3—Drilling and Production in Iran Outside Consortium Area in 1960

Drilling

All by National Iranian Oil Company (NIOC) or by firms composed jointly of NIOC and private interests.

[1]Company and Field or Area	[2]Type of Drilling	Wells and Footage Drilling in 1960		Wells Drilling, End 1960
		Wells	Footage	
NIOC alone:				
Sarajeh	Dev.	2	24,005	2
Alborz 8	Dev.	1	11,525	.....
Gorgan	Explo.	3	16,707	1
Total, NIOC alone	.....	6	52,237	3
NIOC Jointly With:				
IPAC	Explo.	2	25,648	.....
SIRIP	Explo.	1	11,012	1
Total	.....	9	88,897	4

Crude Oil Production

(All in Naft-I-Shah field; all by NIOC.)

ITEM	Amount or Number	
	1960	1959
Total Barrels	2,370,996	1,914,853
(Barrels Daily)	6,478	5,246
Crude Oil Producing Wells at End of Year	8	8
Flowing	3	4
Pumping	.....	.....
Shut In	5	4

[1] Abbreviations—NIOC: National Iranian Oil Co; IPAC: Iran Pan American Oil Co.; SIRIP: Societe Irano-Italienne des Petroles.
[2] Development or exploratory.

TABLE 4—Refining in Iran in 1960

Area, Refinery Location, and Company Operating Refinery	Plant Capacity (Barrels Daily)	Crude Runs to Stills (Barrels Daily)
a. Consortium are (South Iran), Abadan, Iranian Oil Refining Co.	412,000	352,000
b. Outside Consortium Area, Kermanshah, National Iranian Oil Co.	3,000	2,800
Total, 1960	415,000	354,800
Total, 1959	415,000	324,279

Note: Table excludes a 5,000-bpd topping plant at Naft-i-Shah field, which charged an average of 4,700 bpd in 1960; and a 75,000 bpd topping plant at Masjid-i-Sulaiman field, which was reported to have charged an average of 43,700 bpd in 1960.

Kharg should prove to be a very important shipping point for Iranian oil in the future. It has many advantages, including the high potential of Gachsaran field and a design capacity of the system to move 330,000 bpd *by gravity flow* alone. Kharg is closer to world markets than other Iranian oil ports. The port of Bandar Mashur is limited by a narrow channel through the Khor Musa bar, hence it is unlikely that Bandar Mashur will ever handle tankers much larger than 45,000 tons. Access to Abadan is vulnerable to boundary disputes with Iraq. A river pilot strike early in 1961 reduced tanker loadings to the extent that April 1961 thruput at Abadan averaged only 155,000 bpd, less than half of normal.

Activities outside south Iran. National Iranian Oil Co., the government agency, administers the Iranian oil industry, operates actively in central Iran and owns half interests in the partnership firms Societe Irano-Italienne des Petroles (SIRIP) and Iran Pan American Oil Co. (IPAC).

During 1960 NIOC's new statutes were approved by Parliament, the company's capital was increased, and its administration was reorganized. Highlights of its 1960 operations were

- Evaluation of the new Sarajeh gas-condensate field to determine means of utilizing this deposit and to move gas to Teheran and Isfahan
- Continued exploration in Gorgan, central plains, Kermanshah and other interior areas.

NIOC boosted production from Naft-i-Shah field to 2,370,996 barrels last year, an average of 6,478 bpd for a 23.5 percent increase compared to the 5,246 bpd rate of 1959. Three oil wells were flowing at the end of 1960, with five other oil wells shut in. Efforts were expected to expand Naft-i-Shah's productive capacity substantially in the future.

Most of last year's crude output at Naft-i-Shah was processed at the field's topping plant. Capacity was rated at 5,000 bpd, with an average of 4,700 bpd processed last year. Crude and topped crude are piped to the Kermanshah refinery.

NIOC reported receipt of 5,609,145 barrels of fuel oil from the Masjid-i-Sulaiman topping plant in south Iran last year, an average of 15,326 bpd.

At Sarajeh, well 3 was drilled to 12,180 feet and awaited testing at the end of December. Sarajeh 4 bottomed at 11,825 feet and tested gas and salt water. At Alborz, the previously indicated prolific oil production is still proving to be elusive. Alborz 8 produced a high volume of oil and salt water on initial tests. Total depth was 11,525 feet.

At Gorgan on the Caspian Sea plain, wells 1, 3, and 4 bottomed at 6,593, 6,859, and 3,255 feet respectively. A Tertiary sandstone tested gas in Gorgan 3 and the other two wells were dry.

Products pipe lines were being extended by NIOC in interior Iran. The Tehran-Shahrud 235-mile, 8-inch line

was completed last year, and steps were taken to extend it to Meshed.

The 170-mile Gachsaran-Shiraz gas line was completed to provide feedstock to a fertilizer plant. Additional projects were being considered by NIOC to provide full utilization of the nation's natural gas supplies. NIOC has formed a new gas utilzation firm.

NIOC reported gas production in Iran at more than 266,131 MMcf (727,134 Mcfd) last year, of which only 14 percent was utilized as fuel or feedstock. Twenty-five percent was used in turbines and then flared with the remaining 61 percent.

SIRIP. The first offshore test drilled by this joint Italian-Iranian firm has evidently been completed as an oil discovery and is believed to be commercial, probably good for about 3,600 bpd initially. Bargansar 1 was drilled to 11,012 feet after finding oil at 7,050 feet in the Asmari formation and at 8,850 feet in the Cretaceous Bangestan horizon. In October the deviated test Bargansar 2 was spudded from the same fixed platform. The confirmation test was intended to bottom 2,625 feet horizontally distant from the first hole. Production and loading facilities for tankers up to 48,000 dwt were completed by the end of December, and 375,000 barrels of crude had reached Italy by May 1961. An average of about 6,150 bpd was expected to be lifted from the new field this year.

By July 1, 1961, Bargansar 1 and 2 were undergoing production tests, and preparations to drill well 4 from the fixed platform were underway. A mobile platform had been brought in to help drill up the field and had spudded SIRIP's offshore well 3.

IPAC. Two wells had reached total depth in IPAC's offshore concession by the end of 1960, well A1 which bottomed at 13,151 feet and B1 at 12,497 feet. Well A1 had been undergoing tests in mid-1961 in several possible oil zones for more than a year. IPAC B1, located about 22 miles south of Kharg Island, 20 miles from the mainland shore and 60 miles southeast of A1 was suspended as a non-commercial producer early in 1961.

As of July 1, 1961, IPAC had two new wells drilling, C1 at 2,757 feet and D1 at 5,920 feet.

Iraq... production and political uncertainty are both rising. Pipe line capacity is increased

IRAQ'S OIL OUTLOOK was a mixture of progress and confusion as of mid-1961. Crude oil production from Iraq Petroleum Co. Ltd.'s Kirkuk, Bai Hassan and Jambur fields in north-central Iraq increased in 1960 and during the first four months of this year compared with the same period in 1960. Mosul Petroleum Co. Ltd., the IPC affiliate operating the northwest Iraq concession, continued to coax about 26,000 bpd production from 5 flowing wells in Ain Zalah field and 1 pumper at Butmah. However, the IPC subsidiary operating in south Iraq at the head of the Persian Gulf, Basrah Petroleum Co. Ltd., was hampered by a dispute with Basrah port authorities following an increase of cargo dues on oil shipments from Fao imposed in mid-1960. Output from Rumaila and Zubair fields has thus decreased, despite strong increases in producibility (now about 450,000 bpd) in these southern fields in recent years.

Hence, the situation that followed the detonation of the IPC pipe lines in Syria during the Suez crisis of 1956-57 was partially reversed. Before the lines were repaired, output from Kirkuk, Ain Zalah and Butmah was curtailed while BPC's crude yield soared.

Progress was made in 1960 and 1961 toward increasing capacity of the IPC pipe lines. In the south, construction of an entirely new port was started at Umm Qasr in 1961. Although this development had no direct bearing on oil, eventual completion of the port may relieve congestion caused largely by tanker traffic to and from Abadan and Fao at the head of the Persian Gulf. BPC's new deep water terminal south of Fao was nearing completion in mid-1961 (WORLD OIL, August 15, 1960, Page 201).

On the negative side, negotations between the government and IPC, which will have a strong bearing not only on the course of existing operations but also on the conditions under which new oil companies might enter Iraq in the future, have continued intermittently for the past year. Some progress has been made, but full agreement had not been reached by mid-1961. The government's bargaining procedures were somewhat analogous to its rather bizarre conduct of foreign policy.

Crude oil production in Iraq increased by 13.6 percent from 852,907 bpd in 1959 to 968,830 barrels daily in 1960 (Table 1). Production rates last year increased from 900,780 bpd in January to 1,038,297 bpd in December. During the first four months of 1961 production amounted to 117,964,970 barrels or an average of 983,041 bpd, up 5.9 percent compared with the same period in 1960. This included increases by IPC to an average of 755,990 bpd during the January 1-April 30 period and by MPC to 26,455 bpd. BPC's production continued to lag, averaging 200,596 barrels daily during the first third of 1961.

Operations in 1960 are described by companies as follows:

IPC boosted crude oil production by 23.5 percent from 568,118 barrels daily in 1959 to 701,552 bpd in 1960 (Table 1). At the end of December IPC had 52 oil wells on production, including 44 at Kirkuk field, 6 at Bai Hassan and 2 at Jambur. Twenty-five additional oil wells were shut in, including 21 at Kirkuk and 2 each at Bai Hassan and Jambur.

In June 1960 Bai Hassan field began production. A 20-mile, 12-inch pipe line links the new producing field with K1 pumping station near Kirkuk. By September Bai Hassan, Jambur and Kirkuk were producing at the combined rate of 766,698 bpd.

IPC continued wildcatting last year. Pulkhana 6, about 20 miles southeast of Jambur was drilling at 1,780 feet at the start of 1960 and was abandoned in March at 4,985 feet. Gilabat 2, slightly farther southeast was suspended at 5,162 feet in July 1960. The same month Qara Chauq 1, about 10 miles west of Bai Hassan was spudded and was drilled to 8,535 feet by the end of December. Demir Dagh 1 was a dry hole drilled in 1960

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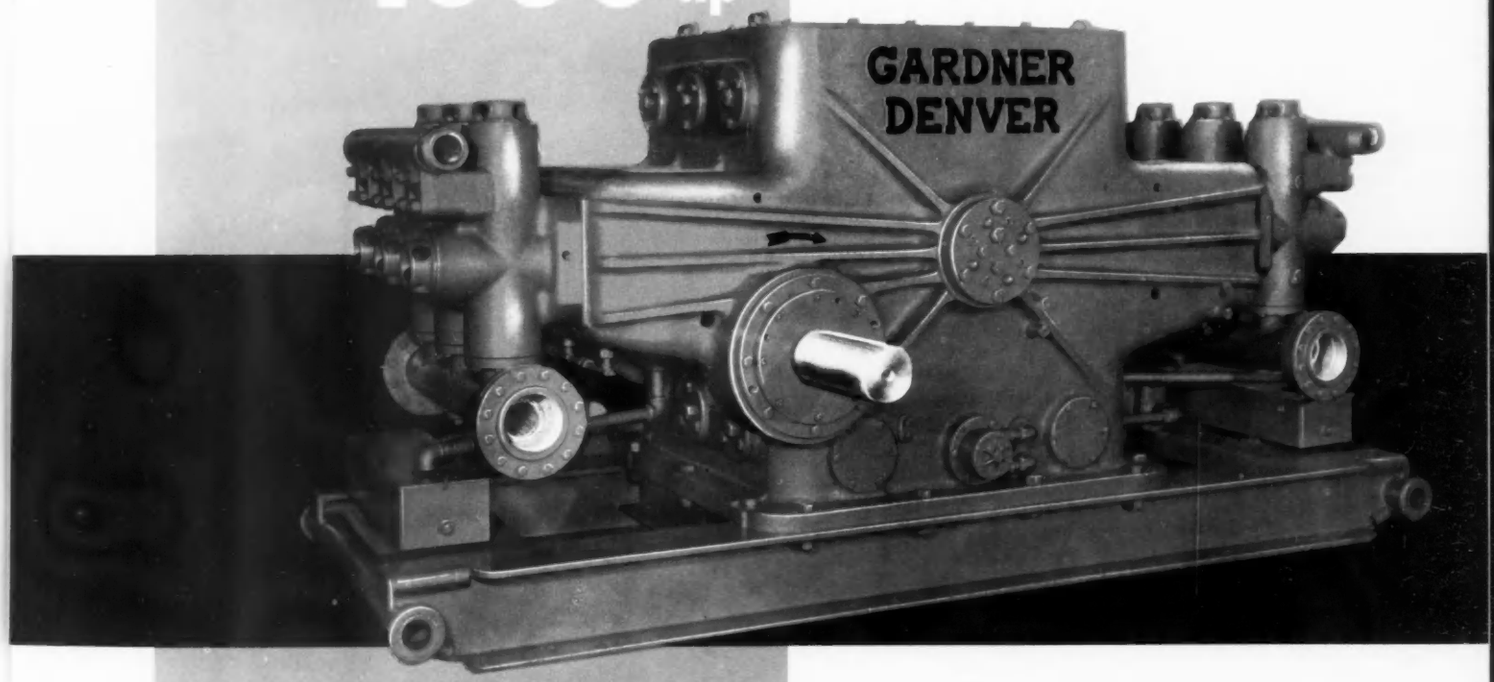
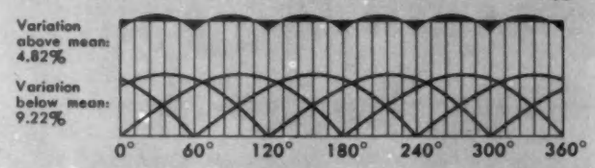
- Scotch yoke design eliminates crossheads, pistons, connecting rods and fluid cylinder head.
- Light weight per horsepower.
- Force-feed lubrication to all power end parts by two lube pumps.

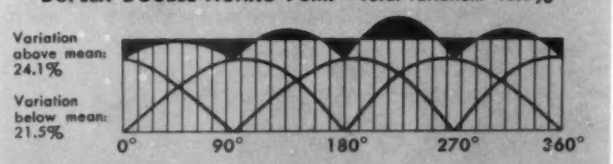


DIAGRAMS OF DISCHARGE FLOW

6-CYLINDER, SINGLE-ACTING PUMP—Total variation: 14.04%



DUPLEX DOUBLE-ACTING PUMP—Total variation: 45.6%



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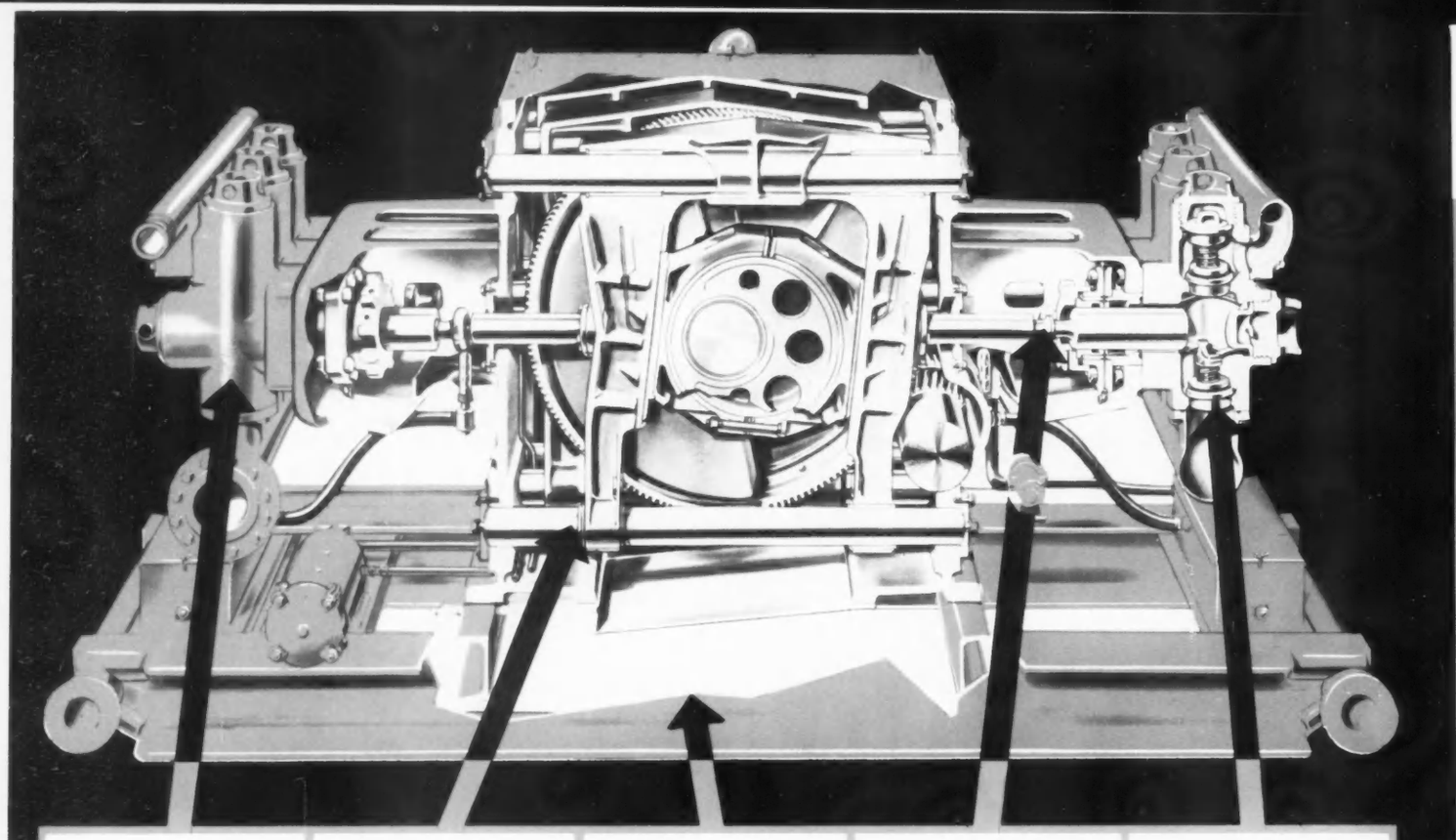
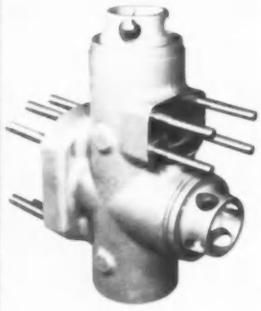
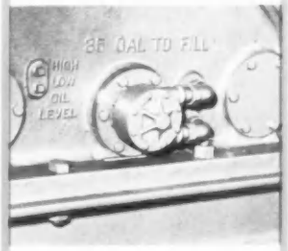




Individual, heavy forged and heat-treated alloy steel cylinders withstand high pressures. Cylinders may be replaced individually. Threaded valve covers permit quick inspection or replacement.

Scotch yoke and follower ribbed to provide adequate strength, without excess weight. Replaceable bronze bearings on all wearing surfaces.



Lubricating system includes two gear-type oil pumps, driven from main gears and connected in parallel for maximum safety. Pumps are mounted outside crankcase for easy checking or servicing.

Gardner-Denver plungers are hard-surfaced to resist corrosion and extend wear life. Plungers disconnect quickly from push rods, and are readily removed through suction valve opening.

Gardner-Denver valves and seats for suction and discharge are forged of alloy steel, hardened on seating and guide surfaces. Valve inserts are of improved design. Upper valve guides are renewable.

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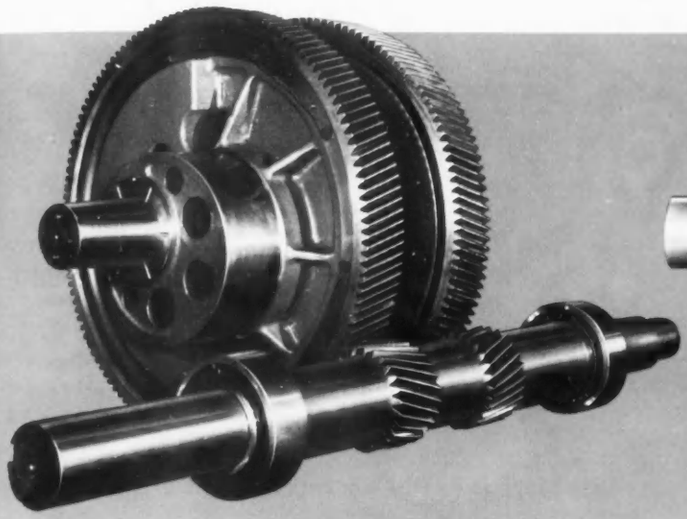
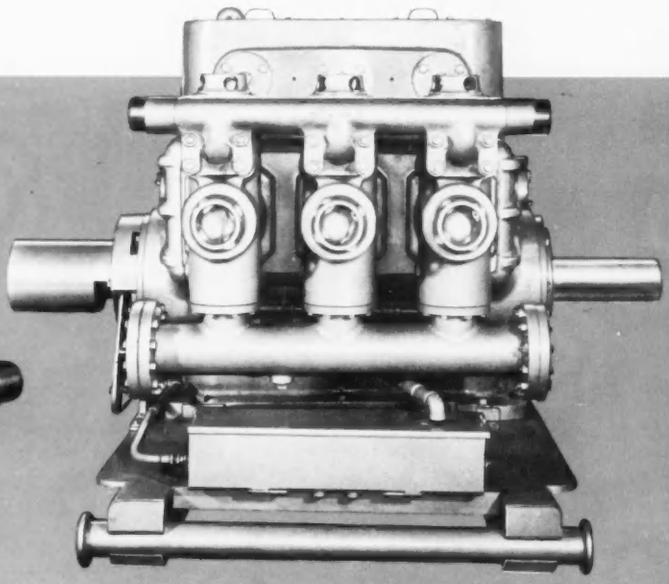
- Smooth discharge flow because of true harmonic motion from Scotch yoke design and multiple cylinders. Design tested over five years by Gardner-Denver.
- No pulsation dampener required for smooth operation.
- Individual, interchangeable, *forged steel fluid cylinders.*
- Smaller, lighter fluid end parts for quick, easy maintenance.
- Cylinders are designed so that plunger can be removed through suction valve opening.
- Scotch yoke design eliminates crosshead, pistons, connecting rods and fluid cylinder head.
- Light weight per horsepower. Weight of 700 hp pump, skid-mounted: 28,000 lb.
- Accessible plungers and packing easily changed.
- Force-feed lubrication to all power end parts by two lube pumps.
- High volumetric efficiency (95-97%) with use of charging pump.
- Long plunger life.
- Forged alloy steel, crown-shaved gears.



Eccentric counterweights are cast integrally. Crown-shaved gears are cut on heat-treated alloy steel forgings and bolted to eccentric. Bearings are bronze on hardened steel shaft. The double extended jackshaft, carried on roller bearings, permits driving from either side.



Valve chambers are integral with individual die-forged and heat-treated alloy steel cylinders. Suction and discharge manifolds operate off either side of pump.

You get versatility in a compact package

The rugged construction of Gardner-Denver's PO and PV pumps centers on Scotch yoke design. Scotch yoke provides compact crankcase—eliminates useless weight, eases moving problems. Yet, you get the horsepower and pressures you need for jet bit drilling, for drilling to extreme depths and for well servicing. The versatility of these pumps permits you to change from one type of service to another simply by disengaging plungers on one end. Operate pump at full power on six cylinders for continuous mud service. Or use either bank of three cylinders for high-pressure, intermittent service for well servicing, well killing, cementing, fracturing, acidizing and workover services—or for emergencies during drilling operations.

When operated with six cylinders for continuous service, pump ratings are:

PO-7—700 hp input at 130 rpm; maximum pressure, 4493 psi, or maximum displacement, 668 gpm; plunger load, 43,161 lb.

PV-9—1000 hp input at 125 rpm; maximum pressure, 5000 psi, or maximum displacement, 825 gpm; plunger load, 50,000 lb.

When operated with three cylinders for intermittent service, pump ratings are:

PO-7—700 hp input at 130 rpm; maximum pressure, 8986 psi, or maximum displacement, 334 gpm; plunger load, 86,322 lb.

PV-9—1000 hp input at 125 rpm; maximum pressure, 10,000 psi, or maximum displacement, 412 gpm; plunger load, 100,000 lb.

For complete specifications, write for Bulletin PO-V.

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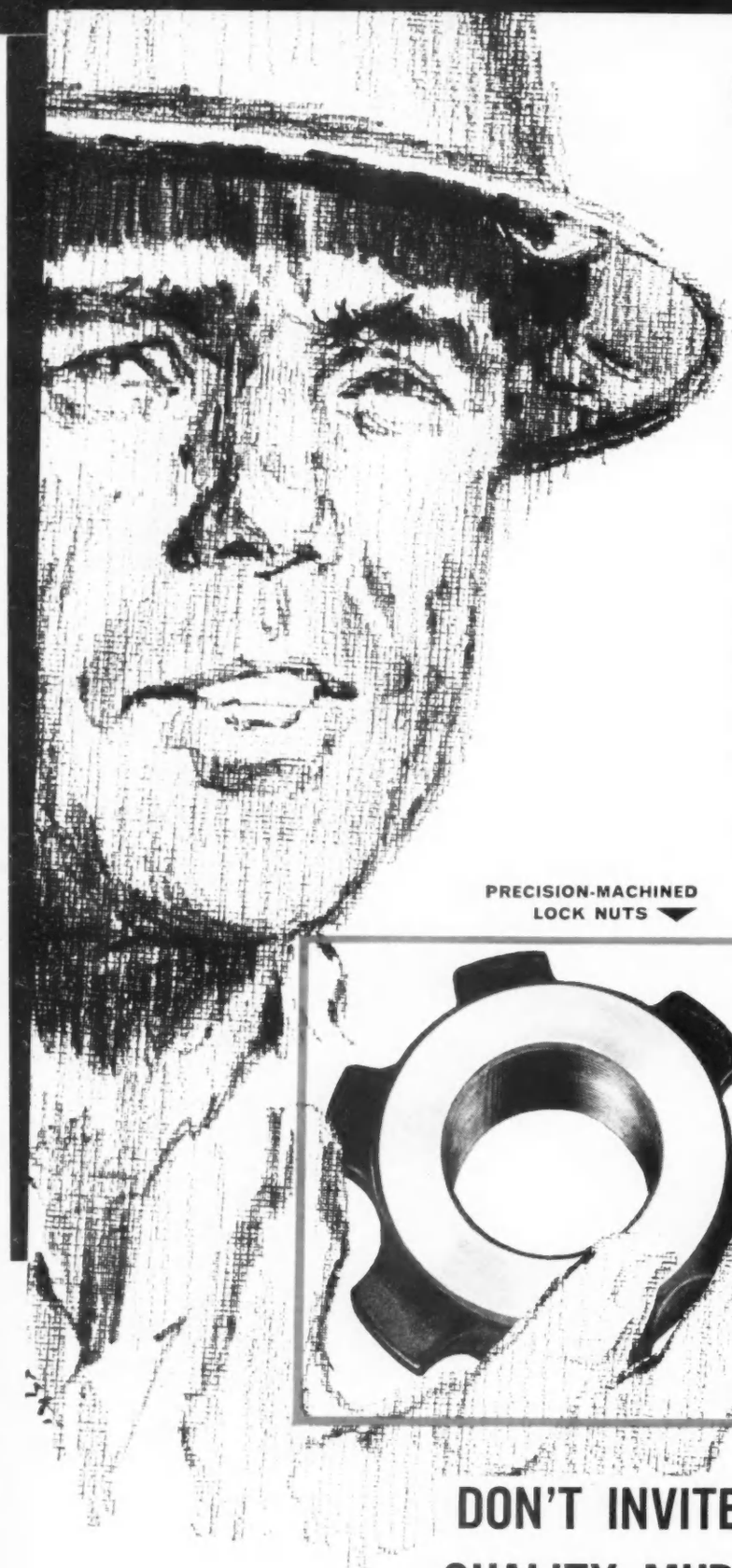

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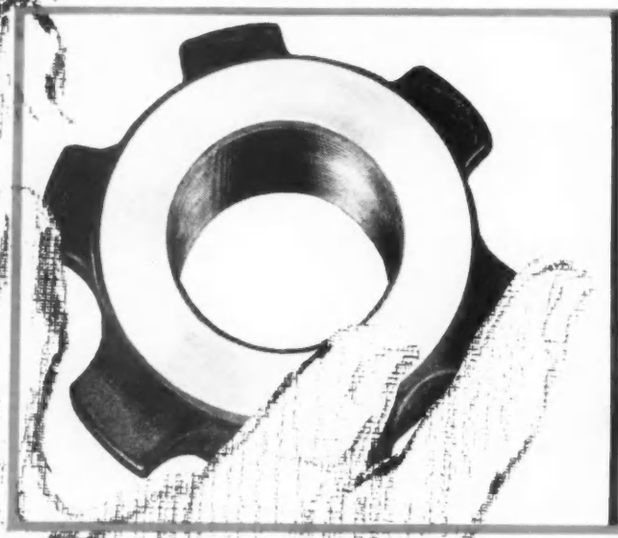

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north of Kirkuk to 8,755 feet. Taq Taq 1, another wildcat north of Kirkuk, was spudded in December and reached 475 feet by the end of the year. Chemchemal 2, a wildcat located about 50 miles east of Kirkuk field and suspended in 1953 was deepened last year. Including deepening operations, IPC drilled 49,550 feet of exploratory hole last year. One exploratory well was listed as an oil completion in addition to the three dry holes.

IPC was active in development drilling last year, completing 9 oil wells and 1 dry hole, comprising 35,234 feet of hole.

Pipe line construction was active as IPC continues to expand capacity of outlets to Mediterranean ports at Tripoli, Lebanon and Banias, Syria. Looplines paralleling the 555-mile Kirkuk-Banias 30/32-inch line have been under construction since 1957. By April 1960, 306 miles of new line across Syria had been completed, and the following month a 38-mile section was finished from a point near Homs to Tripoli. Work is underway on 249 miles of new loops in Iraq. Most of the remaining work as of December was to be done between K3 pump station (near Haditha) and T-1 station about 55 miles to the west. The new pipe line loops and improvements in existing pumping stations will provide the IPC system with a thruput capacity of more than a million barrels daily.

MPC produced an average of 26,119 bpd at Ain Zalah and Butmah fields, 1.8 percent more than the 25,666 bpd rate of 1959 (Table 1). Mosul completed 3 development wells, all for oil, involving 29,139 feet of hole, and 1 dry wildcat. MPC continued the Samarra 1 test 70 miles northeast of Baghdad and abandoned it in May 1960 at 11,511 feet. Alan 2, located about 20 miles southeast of Butmah field was spudded in June 1960 and reached 8,677 feet at the end of December.

In addition to the 5 flowing wells at Ain Zalah and the 1 Butmah pumper on production at the end of 1960, 5 oil wells were shut in at Butmah and 1 at Ain Zalah.

BPC produced an average of 236,159 barrels daily last year, 7.6 percent below the 1959 average of 255,523 bpd (Table 1). Eight new oil wells aggregating 96,676 feet of hole were completed in Rumaila and Zubair fields.

Very significant extensions have been made at both Rumaila and Zubair fields in the past several years. Rumaila 21 is an important northward extension. Rumaila field was about 27 miles long parallel to its axis (slightly northwest of due north) and a maximum of 8 miles wide toward its southern extreme. Zubair appears to be about the same areal size, though inside locations evidently were yet to be drilled to prove a 4½-mile gap between Zubair wells 15 and 17.

In addition to proven production at Rumaila and Zubair, some evidence indicates that oil was found farther north at Nahr Umr in two wells drilled 19 miles northwest of Basra some years ago. The last mention of this area in annual IPC reports released for publication was in the review of 1958 operations. Nahr Umr 3 reached 10,109 feet in November of that year when drilling was suspended.

At the end of 1960, there were 13 flowing wells at Rumaila and 14 shut in; and 26 flowing wells at Zubair and 11 shut in.

Basrah's wildcatting continued, with five dry holes completed and 35,127 feet of exploratory hole cut last year. Tuba 1, located between Rumaila and Zubair fields, was abandoned at 11,940 feet. Kifl 1 located farther north, about 60 miles south and slightly west of Baghdad was abandoned at 10,684 feet. Shawiya 1 located 150 miles west of Rumaila was abandoned at 5,860 feet. Dujaila 1, located about 110 miles northwest of Basrah was spudded in May and had reached 13,394 feet at the end of December. It was the deepest test yet drilled in Iraq.

In addition to two other wildcats abandoned last year BPC spudded Afaq 1 about 180 miles northwest of Basrah and had drilled it to 10,433 feet at the end of the year.

In the Basrah area one stage of the plan to increase productive capacity to 460,000 bpd in southern Iraq was completed September 22 when the laying of 64 miles of 30/32-inch pipe line between Zubair and Fao was finished. The new line parallels the 24-inch line commissioned in 1954. The original 12/16 inch line completed in 1951 has now been converted to a gas line to allow Rumaila gas to be used in combustion turbines in connection with the new deep water terminal at Fao.

Government operations. Crude oil production at Naft Khaneh field in the former Khanaqin Oil Co. (Chia Surkh) concession is believed to have been stepped up slightly to about 5,000 bpd. The government is believed to have done some seismic work, and press reports early in 1961 indicated that Russian drilling equipment would be used in the area in the future. Cooperation was reported between government agencies of both Iraq and Iran to boost productive capacity of the field. The Iranian side of the field, which straddles the border, is called Naft-i-Shah.

In 1960 the Iraq Ministry of Industry instructed Ewbank and Partners Ltd., engineering consultants of London, England to obtain tenders for a gas pipe line from BPC's Rumaila degassing station to the new Basrah power station and to the site of a proposed fertilizer plant at Abul Flus. Early in 1961 SAIPEM, of Milan, Italy won the contract. The buried line includes 22 miles of 18-inch, 16 miles of 14-inch, and 19

TABLE 1—Crude Oil Production, Producing Wells, and Drilling in Iraq in 1960

COMPANY	CRUDE OIL PRODUCTION					Producing Wells Yr. End	WELLS COMPLETED			FOOTAGE DRILLED	
	Barrels		Barrels Daily		% Diff.		Oil	Dry	Total	In Year	Cumulative
	1960	1959	1960	1959							
Iraq Pet. Co., Ltd.	256,767,989	207,363,000	701,552	568,118	23.5	52	10	4	14	84,784[1]	715,663
Basrah Pet. Co., Ltd.	86,134,127	93,266,000	236,159	255,523	—7.6	39	8	5	13	131,803	916,226
Mosul Pet. Co., Ltd.	9,559,735	9,368,000	26,119	25,666	1.8	6	3	1	4	40,650[1]	526,033
Iraq Government[4]	1,830,000	1,314,000	5,000	3,600	38.9	2	..	..	..	.....	.....
Total, Iraq	354,591,851	311,311,000	968,830	852,907	13.6	99[2]	21	10	31	257,237	....[3]
Total, 1959	.....	.....	.....	.....	....	134	11	12	23	138,459	.....

[1] Includes deepening operations. [2] MPC's lone producing well at Butmah field on pump; other wells flowing as of 12-31-60. [3] Not tabulated for lack of data in Khanaqin (Chia Surkh) area. [4] Data estimated.

miles of 10¾-inch pipe. Planned capacity is 66.5 MMcfd with the line operating at 300 psi. It will possibly be extended in the future to serve a plant between Basrah and Qurna.

Iraq's General Board of Oil Affairs was tentatively planning a $56 million, 40,000 bpd refinery at Basra last year. If built, this plant would provide 12,000 bpd of products for export after completion in 1965 or 1966.

A new law, Number 13 of 1961, prescribes the organization of Iraq government oil agencies. The new law evidently has little direct bearing on operations at the present time.

Negotiations. The following were the main points of contention between the government and IPC during the nine months of negotiations which began about August 15, 1960.

- Increase in government income from industry earnings. The government has cited agreements effected in the Middle East since 1957 providing more than 50 percent of profits to the government. IPC questions whether such agreements will actually provide the affected governments more revenue or whether they will merely get a larger proportion of smaller profits and will hence enjoy no net gain over 50-50 contracts.
- More employment of Iraq nationals by the IPC companies, and appointment of Iraqi directors to the board.
- Relinquishment of undeveloped areas. IPC has agreed to drop 100,000 acres of the operating companies' choosing. The government has asked to choose some or all of the acreage to be returned.
- Better conservation of casinghead gas to reduce flaring.
- Priority for Iraqi tankers in charters to move Iraq crude. There are several other issues.

Owing to inability of the two parties to agree, the Iraq government ordered the operating companies to suspend exploration in 1961. This is a violation of the original concessions and apparently affects geophysical work as well as wildcat drilling. IPC, BPC and MPC conducted a total of 15 party months of geological work, 71 crew months of seismic reflection and 1 party month of refraction work in 1960.

Kuwait . . . crude yield up 17 percent; nears 2 million bpd; offshore areas are granted

EXPANSION CONTINUED in Kuwait in 1960 and 1961. Crude oil output is approaching 2 million barrels daily as the small shaikhdom continues to lead the rest of the Middle East in both crude oil production and reserves. A new commericial oil field at Minagish west of older fields was confirmed and put on production by Kuwait Oil Co. Ltd., operator of the onshore concession. And negotitation for a concession on Kuwait's offshore areas was finalized early in 1961 when an agreement between Royal Dutch Shell and the Kuwait government was signed.

TABLE 1—Oil Operations in Kuwait in 1960

(All by Kuwait Oil Company Limited)

Crude Oil Production (Barrels)

Total 1960	Daily 1960	Daily 1959	Percent Increase
594,278,196	1,623,711	1,383,165	17.4

Crude Oil Producing Wells at End of Year

Year	Flowing	Pumping	[1]Other Wells	Total
1960	367	.....	20	387
1959	319	.....	38	357

Field Wells Drilled During Year

Year	Oil	Gas Injection	Dry	Total
1960	22	..	....	22
1959	47	1	....	48

Footage Drilled During Year

Year	Development	Exploration	Total
1960	103,124	.....[2]	103,124
1959	202,000	20,254	222,254

Wells Drilling

December 31, 1960	3[3]
December 31, 1959	2

[1] Unconnected, injection, etc. [2] Excludes footage of Mutriba 2, drilling as of 12-31-60. [3] 2 development wells and 1 wildcat; excludes structure hole at Mityaha.

TABLE 2—Growth of Kuwait Crude Oil Production Since Start in 1946

YEAR	Total Barrels	Barrels Daily	Percent* Gain
1946	5,927,979	16,241	.....
1950	125,722,396	344,445	2,020.1
1955	398,493,597	1,091,763	217.0
1960	594,278,196	1,623,711	48.7

* Over figure on preceding line.

Crude oil production amounted to 594,278,196 barrels in 1960, an average of 1,623,711 bpd, an increase of 17.4 percent compared to the 1959 average of 1,383,165 bpd (Table 1). The average annual increase in Kuwait's output between 1955 and 1960 has been 8.5 percent. Crude yield during the first four months of 1961 was reported at 1,704,982 bpd for about a 10 percent boost compared to the same period in 1960.

Forty-eight new wells were connected last year, increasing the number from 319 at the end of 1959 to 367 (all flowing) at the end of 1960. Eighteen new wells were connected in Burgan field, 3 in Minagish and 27 in north Kuwait. KOC's Gathering Centern No. 15 was built in Raudhatain field and commissioned in April 1960. By the end of last year an average of 160,000 bpd was being pumped 63 miles from this installation to Ahmadi via the 30-inch pipe line.

At Minagish, a temporary flow station was built to allow production of up to 25,000 bpd pending construction of permanent facilities. Five wells were on production there as of April 1961. Minagish 1 discovered oil in May 1959.

Fifteen wells were worked over in the Burgan-Magwa-Ahmadi fields during 1960, in four cases to eliminate water production. Four wells were worked over in Raudhatain, and a survey of specific gravity and sulfur content was also completed last year in the north Kuwait fields. Field trials of a new radioactivity logging device to determine oil-water contacts in completed wells were conducted late last year. And a pilot desalting and dehydration plant has been installed at Gathering Center No. 10 in Magwa field.

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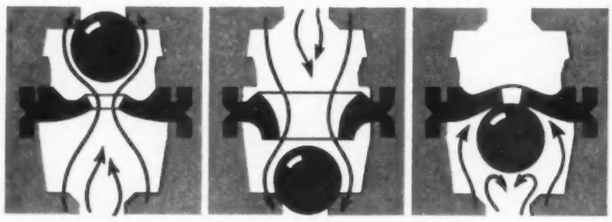

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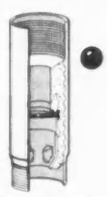

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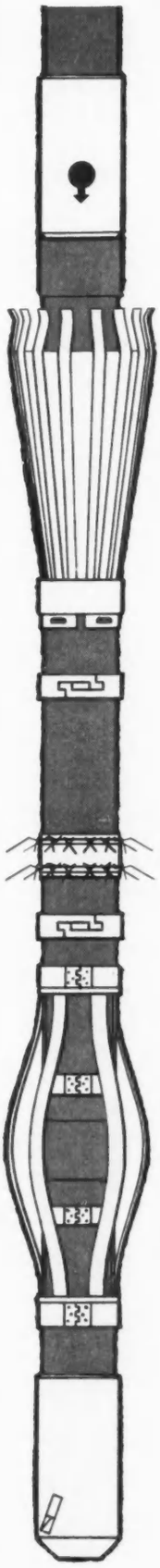

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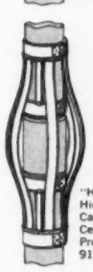

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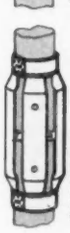

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KUWAIT

Burgan gas injection plant which was expected to be commissioned early in 1961. About 100 MMcf is to be compressed and injected daily. Periodically, surplus distillate, benzine and gas oil from the Mina-al-Ahmadi refinery have been put into the lower Burgan formations via four injection wells.

Three new 262,800-barrel storage tanks were commissioned last year in the North Tank Farm, bringing KOC's crude oil storage capacity to 8,150,000 barrels. About $900,000 worth of new pipe line and storage facilities were added last year.

Drilling. KOC employed two rigs on development drilling last year. The first development phase at Raudhatain was completed early in the year, when 27 wells had been drilled. Eighteen wells were completed in Burgan field. Two development wells, including one at Minagish where there were 2 completions in 1960, were drilling as of the end of December.

A second exploratory well was drilling at Mutriba in northwest Kuwait at the end of December. Mutriba 1 was abandoned in 1958, re-entered and deepened from 10,700 to 11,516 feet in 1959 and suspended due to a fishing job.

Reportedly KOC has budgeted about 40 development wells for 1961, including 30 in Burgan, 3 in Minagish, and the rest in north Kuwait. Five or six rigs are to be operated continuously.

Other exploration. The first of three 8,500-foot structure holes in west Kuwait was spudded in October and was being drilled at Mityaha at the end of December.

A detailed marine seismic survey was conducted in November in Kuwait Bay to follow up previous offshore surveys in the same area in 1957 and 1959.

Refining. Average daily thruput at KOC's 190,000-bpd Mina-al-Ahmadi refinery was 177,439 barrels last year, compared with 142,500 bpd in 1959 and 119,800 bpd in 1958.

New LPG plant. Construction of a 6,350-bpd LPG plant began last August. When completed, this facility will compress and liquefy gas from Gathering Centers 3, 6 and 8 in Burgan field. Condensate will thence be pumped to the Mina-al-Ahmadi refinery where a de-ethanizer, de-propanizer, de-butanizer, and other facilities are being installed. Low temperature storage is being provided the LPG export point at Mina-al-Ahmadi. A tanker is being built to ship this LPG to Japan.

Oil exports. Total crude and products exported from Kuwait last year totaled 561,462,257 barrels. A total of 2,766 tankers were loaded. The largest single oil cargo loaded during 1960 was 105,269 tons.

Offshore concession. One of the world's most prospective offshore areas has now been leased. The agreement was signed on Jaunary 15, 1961. Concessionaire is Kuwait Shell Petroleum Development Co. Ltd. The area is Kuwait's offshore territory in the Persian Gulf lying more than six nautical miles from mean low tide. Excluded are a group of islands and surrounding 6-mile perimeters, which apply to KOC's onshore concession. Among these islands are Warbah, Bubiyan, Failaka, Mischan, and Auha, lying offshore from or north of Kuwait Bay.

The agreement is for 45 years. Shell is obligated to commence exploration in 9 months and to start drilling in 30 months. Shell paid a $19.8 million bonus upon signing: must pay $2.8 million yearly rentals until commercial production, defined as 15,000 bpd, is found; and thereafter (or after the second anniversary date, whichever is sooner) must pay $5.6 million annual rental until regular crude oil exports commence. A deferred bonus of $19.6 million is payable either on the fourth anniversary date of the agreement or when 100,000 bpd production has been maintained for 30 days, whichever occurs earlier. Further deferred bonuses, each of $11.2 million, are to be paid when production reaches 200,000; 300,000; 400,000; and 500,000 bpd for 30 days. A one-eighth royalty is to be paid, either in cash or in kind at the government's option, and profits are to be split equally between the company and the government.

Shell must relinquish 20 percent of the area covered three years after the discovery of commercial oil, and must drop 20 percent of the remaining acreage at the end of each five-year period thereafter.

The Kuwait government may purchase up to a 20 percent interest in the operating company and may do so through a Kuwaiti company whose shareholders will all be Kuwait nationals. The Shaikh of Kuwait may appoint two board members who are named in the agreement. They are Shaikh Jabir Al-Ahmed Al-Subah, president of the Kuwait Department of Finance and Economy, and Mr. H. T. Kemp of London, England.

There is a "favored nations" clause (Article 27) allowing for renegotiation in the event of better future oil terms gained by other Middle Eastern governments. There is also a *force majeure* clause (Article 26).

One of the more interesting facets of this agreement is the rather specific definition (in Article 1) of the offshore boundary between Kuwait and Iraq in the Khor Abdullah, a channel between Bubiyan Island and the delta of the Shatt al Arab (Tigris-Euphrates River). It is noteworthy in this connection that the Shell group also owns 23.75 percent interest in Iraq Petroleum Co. Ltd.

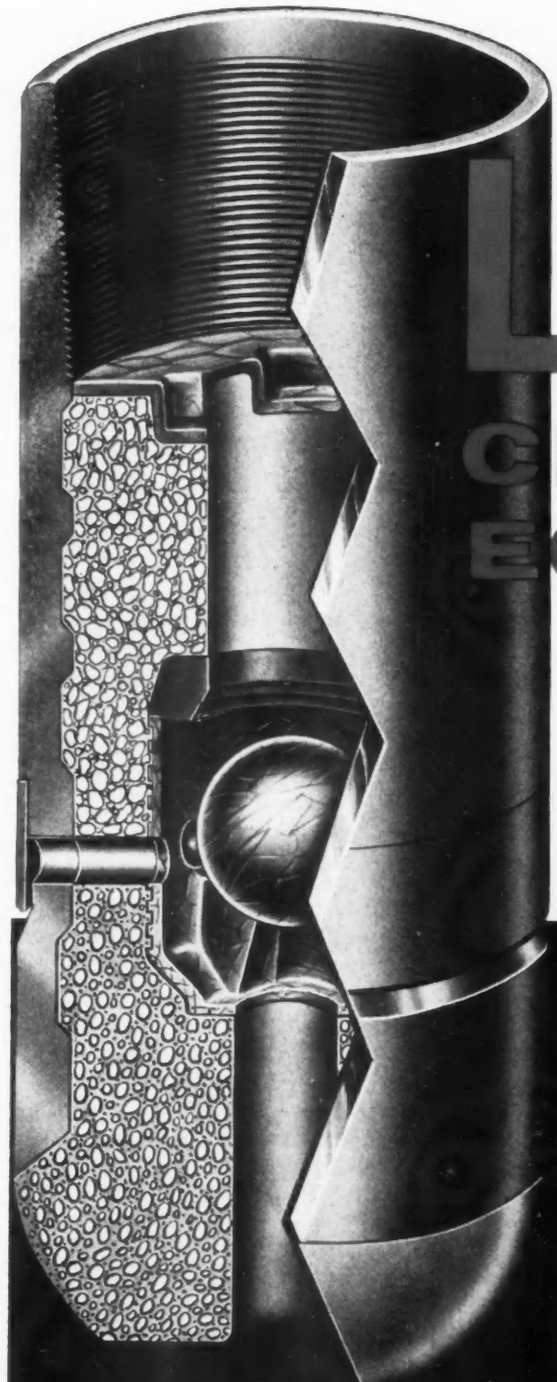
Marine seismic work began in the new offshore concession in March 1961. The first wildcat was expected to spud early in 1962.

ACKNOWLEDGEMENT

The Kuwait-Shell agreement is summarized largely from the February 24, 1961 supplement to *The Petroleum Times*.

Neutral Zone . . . Khafji offshore and Wafra onshore are both proving to be major fields

DEVELOPMENT of major oil fields, Wafra onshore and Khafji offshore, continued at a rapid pace in 1960, one of the most significant of years for the Neutral Zone. Arabian Oil Co., Ltd., continued offshore development with two rigs, and had completed 14 wells at Khafji, *all of them producers* on the same structure, by May 1961. These wells each produce 6,000 bpd or better of 27° API gravity crude from Cretaceous sandstones



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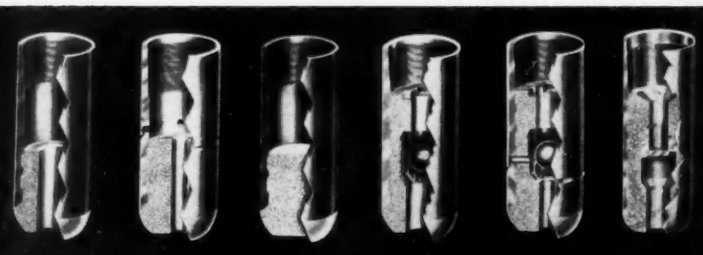

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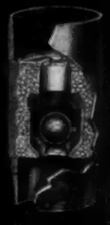

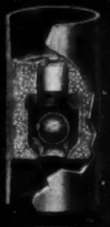

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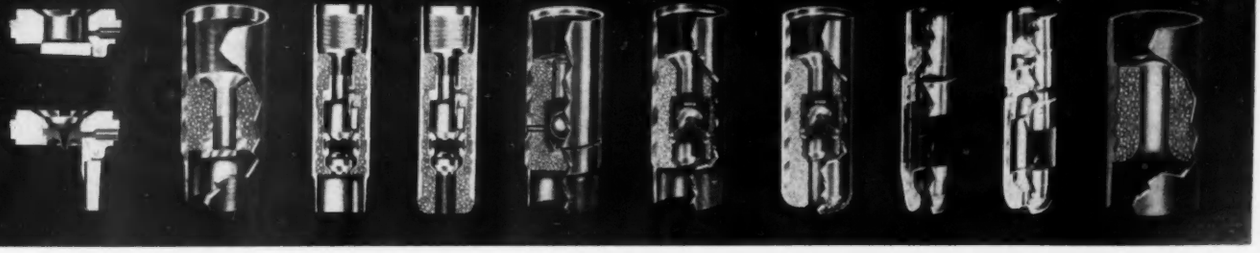
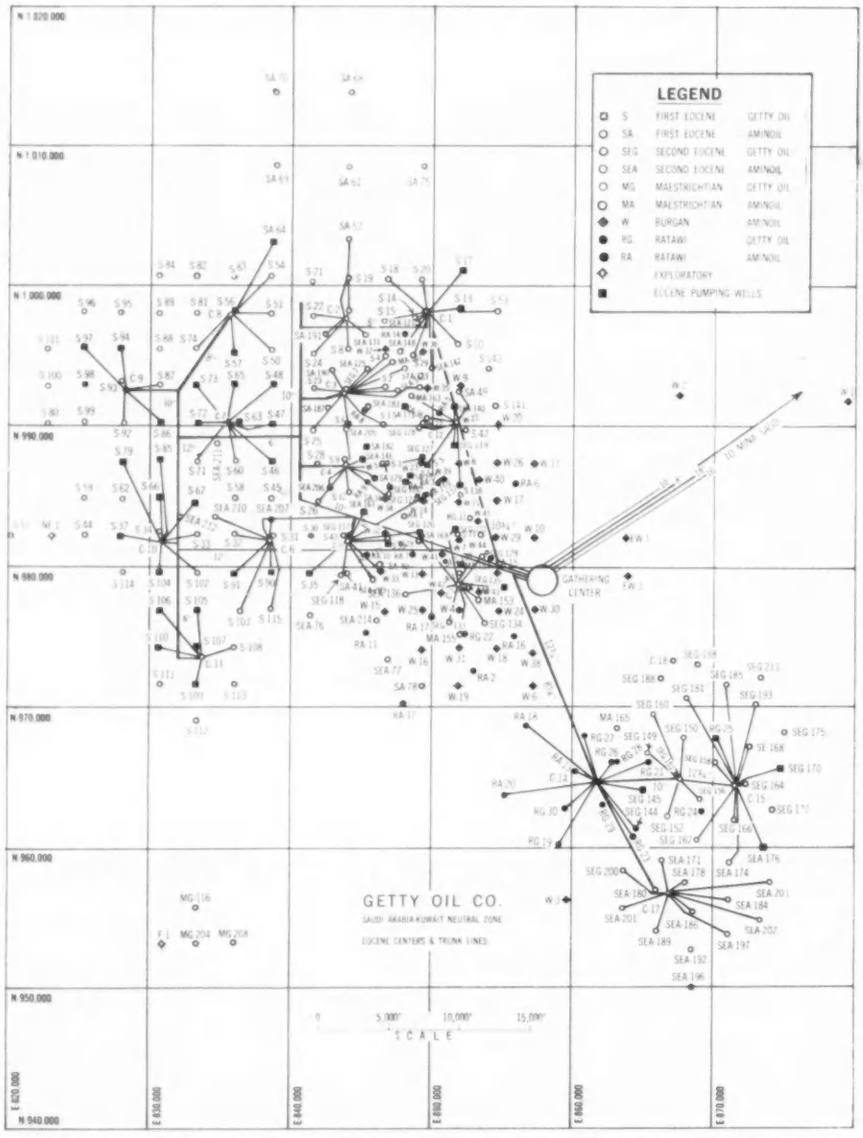


WELLS AND PIPE LINES IN WAFRA FIELD, NEUTRAL ZONE



Courtesy Getty Oil Co. and The Twentieth Century Press, Inc.

This map shows onshore production facilities in the Neutral Zone at Wafra field. At the end of 1960 there were 154 flowing and 48 pumping wells, and 75 wells shut in. Most recent drilling and production activity has stressed the shallower zones, Eocene and Maestrichtian; these wells produce heavy crudes which yield a large proportion of fuel oil. Many of the shallower wells are pumpers.

above 6,000 feet. The first cargo of Khafji crude was shipped to Japan in April 1961.

Offshore activity. Khafji is unquestionably a major oil field. The Japanese operators, (Arabian Oil Co.) report that Khafji is an independent oil source and *not* an extension of Safaniya offshore oil field farther south in Saudi Arabia. However, the reservoir's extent is not yet ascertained. In addition to considerations supporting the theory that Khafji and Safaniya will eventually be joined (International Offshore Report, WORLD OIL, June 1961, page 82), Arabian American Oil Co. has confirmed that Safaniya field has been found to be about twice the size previously known within Saudi Arabia proper. Arabian Oil Company has confirmed that the Cretaceous pay zone at about 5,500 feet at Khafji is the Bahrain zone, instead of Burgan zone as previously reported. The main producing zone at Safaniya is the Bahrain, with a few wells completed in the Zubair horizon.

An additional consideration is the report that the tentative posted price of Khafji crude is specifically calculated to compete with Safaniya crude. The crudes have such similar characteristics as to allow the possibility that they are the same crude.

Arabian Oil is concentrating on development of the Bahrain pay at about 5,500 feet, and expects to have 26 wells completed at Khafji by the end of 1961. The same two rigs were to be continuously employed throughout the year, finishing about one well per rig per month. (A blowout and fire reported in 1961 at Khafji may cause some delay in this program). No wildcats to the Arab zone (Jurassic) were contemplated for the near future.

As of May 1961, Khafji field was producing more than 40,000 barrels daily from nine wells into a 60,000 bpd temporary offshore flow station (see photogaph, WORLD OIL, June 1961, page 80). Storage was provided by five T-2 type tankers anchored nearby.

Permanent facilities, including four onshore flow stations at Ras al Khafji to provide storage for 200,000 bpd production via new 26-inch main submarine pipe line, were planned.

Specific terms of the original concessions with the Saudi Arabian and Kuwait governments were taking effect as development at Khafji advanced. Early in 1961, the Saudi Arabian government exercised its right under Article 28 of its original agreement of December 10, 1957, to buy 10 percent of Arabian Oil Company's paid-up capital. The purchase amounted to $7 million. The Kuwait government was expected to purchase an identical stock ownership. Also, in accord with the original agreements, two Saudi and two Kuwaiti directors were expected to join Arabian Oil Co. and thus to comprise one-third of its board.

Arabian Oil Co. appeared to be under pressure from the Saudi Arabian and Kuwait governments to maintain posted Middle Eastern prices in fact, and under counter-pressure from the Japanese government to sell Khafji crude in Japan "competitively," meaning at discount.

Under Article 27 of the aforementioned Saudi Arab agreement, Arabian Oil Co. would be obligated to commence construction of a refinery

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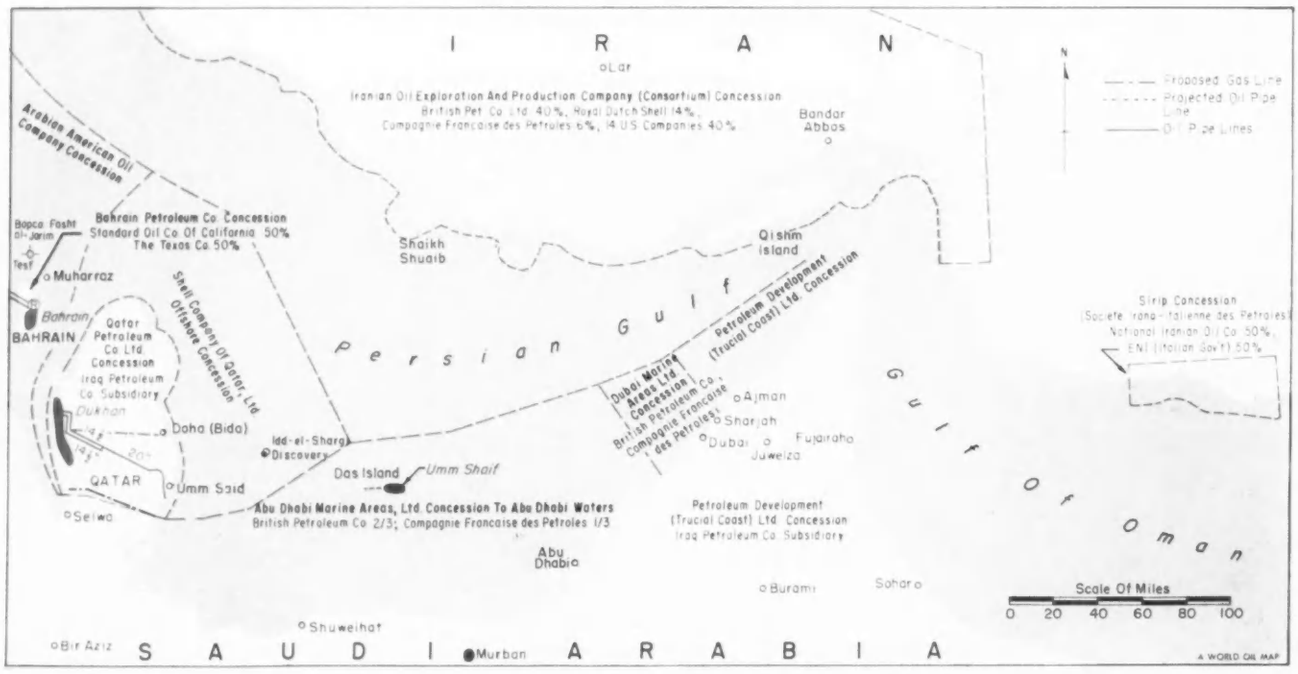

Three similar oil field discoveries have been made or confirmed during the past three years in the South Persian Gulf region, two of them offshore. All were made in Mesozoic formations at between 8,000 and 9,500 feet of depth. Umm Shaif field offshore from Abu Dhabi was being developed and plans for a submarine pipe line to new storage and terminal facilities at Das Island were confirmed by mid-1961. Shell Company of Qatar made a 5,000-bpd discovery in the Jurassic Shibeeb formation last year. Onshore at Murban on the Trucial Coast, an oil discovery at about 8,400 feet indicated by a blowout in 1953 has recently been confirmed. In Iran, the first wildcat to be drilled outside the mainland in the part shown on this map was underway at Shaikh Shu'aib Island in mid-1961.

in Saudi Arabia and complete it in two years. This obligation would be effective when crude oil produced from the concession has averaged 30,000 bpd for a period of 90 days. A similar obligation to build a petrochemical plant applies after 75,000 bpd production has been attained for 90 days.

Onshore operations. Development of Wafra oil field by American Independent Oil Co. (Aminoil) and Getty Oil Co. continued at a rapid pace. Eighty new oil wells were completed, twice the number of 1959 completions, and footage almost doubled also in 1960 when 202,038 feet of hole was drilled compared to 104,267 feet in 1959. Three wells were being drilled at Wafra on December 31, 1960.

Crude oil production last year amounted to 49,830,195 barrels, an average of 136,148 bpd. This was 19,878 bpd or 17.1 percent higher than the 1959 average of 116,270 barrels. Crude oil production at Wafra averaged 156,000 bpd during December 1960. On December 31, the field had 26 Ratawi (Jurassic) wells, 46 Burgan, 197 Eocene and 8 Maestrichtian wells completed, either producing or producible. There were 75 oil wells shut in.

No onshore exploration was reported. However, the onshore Neutral Zone concession includes several islands and submerged waters three miles off these islands and off the mainland. If Khafji fields extends to such areas, Getty and Aminoil may benefit from the offshore development too.

Pipe line capacity is being increased, paralleling drilling developments. A new 32-mile, 24-inch line from Wafra to Mena Abdulla is being built by Contracting and Trading

TABLE 1—Crude Oil Production and Crude Oil Producing Wells in Neutral Zone, by Years

(Onshore production by American Independent Oil Co. and Getty Oil Co.)

YEAR	CRUDE OIL PRODUCTION			CRUDE OIL PRODUCING WELLS AT END OF YEAR			
	Barrels	Barrels Daily	Percent Increase	Flowing	Pumping	Total Producing	Wells Shut In
1960	49,830,195	136,148	17.1	154	48	202	75
1959	42,438,490	116,270	44.8	178		178	19
1958	29,310,000	80,301	26.3	141		141	
1957	23,200,000	63,562	97.9	99		99	

TABLE 2—Wells Completed in Neutral Zone, by Years

(Onshore drilling by American Independent Oil Co. and Getty Oil Co.)

YEAR	WELLS COMPLETED							Wells Drilling, Year End
	FIELD WELLS				Wildcats	TOTAL		
	Oil	Gas	Dry	Total		Wells	Footage	
1960	80			80		80	202,038	3
1959	40			40		40	104,267	3
1958	37		12	49		49	102,424	2
1957	46		8	54		54	110,390	

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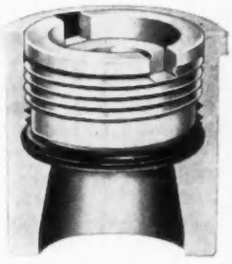

Smith threaded flow nozzle sectioned to illustrate o-ring seal and general construction.

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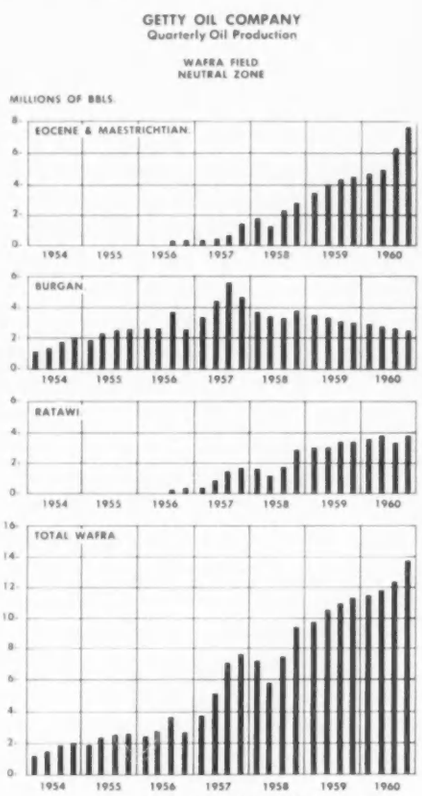
Co., Beirut, Lebanon, for Aminoil, and was expected to be in service in August 1961. Unlike older onshore Neutral Zone crude lines, this one will be buried in order to mitigate or eliminate security problems, need for road and camel crossings, expansion from mid-day heat, etc.

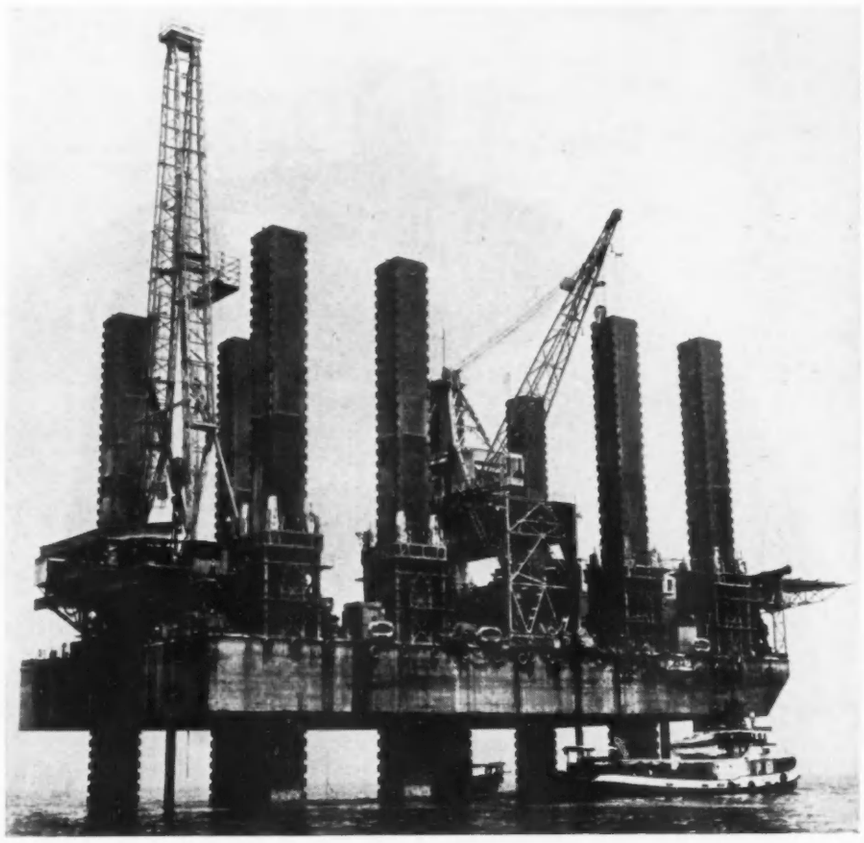
Refinery thruput at Getty's Mina Saud refinery totaled 10,626,666 net barrels last year, an average of 29,034 bpd. Getty reported the loading of a total of 100 tankers during the year (both crude and products).



Courtesy Getty Oil Co. and the Twentieth Century Press, Inc.

Quarterly crude oil production charts of Getty Oil Co. show the growing importance of Eocene and Maestrichtian crudes since 1956, compared to the leveling off of output from Ratawi and Burgen zones. Cumulative effect on total yield from Wafra field is steadily increasing production.

Aminoil's 40,000 bpd capacity refinery at Mena Abdulla, Kuwait, charged an average of about 32,000 barrels of crude daily in 1960. A new 100,000 bpd topping plant and refinery is being built at Mena Abdulla, separate and apart from the original plant. Both will continue to operate after the new one goes on stream early in 1962.



This 5,930-ton mobile drilling platform, designed to withstand winds up to 100 mph and waves 30 feet high while working in 90-foot water depths, is being used to evaluate a new oil field discovery offshore from Qatar. The platform, the "Seashell," accommodates a staff of 70 and includes a heliport. It was built in Holland.

Qatar . . . discovery well offshore yields 5,000 barrels daily. Dukhan field oil production sustained

A 5,000-BARREL-DAILY oil discovery has been confirmed in Qatar's offshore waters. Shell Company of Qatar Idd-el-Shargi 2, drilled from the 5,930-ton mobile drilling platform "Seashell" tested oil at this rate of flow. Location is 52 miles east of the Qatar mainland. The pay formation is the middle Jurassic Shibeeb limestone at about 8,000 feet. This depth was reached in April 1960.

Another structure at Hadet Shibeeb was then tested and found dry about a year ago. The "Seashell" was then moved to within 1¼ miles of the discovery well to drill Idd-el-Shargi 3. It was completed with results similar to the discovery. Both wells are in water depths greater than 100 feet. In March, 1961, the "Seashell" was being moved to drill Idd-el-Shargi 4.

Although it was not known whether the new field is commercial, the 1960 *Shell Review* refers to it as "encouraging."

Onshore, Qatar Petroleum Co. (QPC) continued to produce Dukhan field at its MER of about 175,000 bpd in 1960 and thus far in 1961. Crude oil production last year averaged 174,611 bpd, a 2.5 percent increase compared to the 1959 average of 170,403 barrels daily. The 1960 total was 63,907,684 barrels. One new oil well was completed last year to add to the 50 wells producing at the start of 1960. A dry wildcat, Fuwairat 1, was drilled also. Total footage onshore was 14,344 feet. QPC reported no other exploration activity and no wells drilling at the end of 1960.

Crude oil production during the first five months of 1961 averaged 178,767 bpd, 2 percent more than during the same period last year.

QPC will build a 60-mile gas pipe line from Dukhan field to Doha. The line is to consist of 50 miles of 10-inch and 10 miles of 6-inch pipe. Completion is slated during 1961.

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Saudi Arabia . . . field drilling nets vast oil reserves; pressure maintenance pays

QUIETLY and with little fanfare, Saudi Arabia's oil industry made momentous strides in 1960 and thus far in 1961. Crude oil production increased by 13.9 percent in 1,247,140 barrels daily in 1960, compared to the 1959 average of 1,095,399 bpd. Safaniya field, by 1957 already the world's largest marine offshore oil deposit, was doubled in known size in 1960 by stepout wells completed within Saudi Arabia proper (i.e., south of the Saudi Arabia-Kuwait Neutral Zone). Crude oil reserves in Saudi Arabia were increased by seven million barrels despite the record 1960 crude yield. Pressure maintenance has definitely reversed the formerly serious reservoir pressure decline at Abqaiq field, which registered a healthy increase in crude oil output last year. Khursaniyah field is now on production. And new facilities at Ras Tanura, Saudia Arabia's oil exporting and refining center, provide a significant new blending service to offtakers of Saudi Arabian crude and products and blends of both.

Production. The record 1960 crude yield was mainly due to increases outside of the mammoth Ghawar field, which produced 714,257 bpd in 1960 (Table 1), only 12,411 bpd more than in 1959 when 701,846 bpd was lifted at Ghawar. Arabian American Oil Co. (Aramco) listed 86 wells on production at Ghawar at the end of 1960, five fewer than the 91 producing at the end of 1959. As elsewhere in the Middle East and other areas where producibility strongly exceeds current production, Saudi Arabian oil yields are strongly geared to demand for particular crudes. Last year there was a strong increase in demand for Safaniya crude. In its third full year on production, Safaniya crude oil output more than doubled in 1960 from 76,177 bpd in 1959 to 181,076 barrels daily last year.

Not only the flush newer fields in Saudi Arabia registered expected increased outputs in 1960; the older ones, Abqaiq, Dammam, and Qatif showed increases too. Abqaiq increased by 12.1 percent from 267,316 bpd in 1959 to 299,714 in 1960; Dammam and Qatif showed lesser gains from 34,056 bpd and 16,004 bpd respectively in 1959 to the slightly greater daily averages shown in Table 1.

OIL FIELDS OF SAUDI ARABIA

Very significant extensions of Safaniya and Khurais oil fields have been made during the past two years. Neither offshore field (Safaniya or Manifa) had been fully delimited as of mid-1961. Khursaniyah field has now gone on production and Abu Hadriya is being drilled up preparatory to being tied into the Trans-Arabian Pipe Line system.

A single-day record was set in Saudi Arabia on November 22, 1961 when 1,492,697 barrels was produced. Average daily production in December was 1,392,014 barrels, the highest in any month in Aramco's history at that time. This monthly record was promptly broken in February 1961 when 1,547,187 bpd was produced. Crude oil production during the first five months of 1961 was 217,496,078 barrels, an average of 1,440,371 bpd.

New facilities to handle increased production have been built. The previous plan to batch Safaniya and Khursaniyah crudes thru the original 22-inch pipe line to Ras Tanura was shelved. Volume proved too great, and a new 62-mile 30-inch Khursaniyah-Ras Tanura line was added. It was completed on October 2.

Installation of three 8-inch flowlines, aggregating 21,000 feet of line to connect new wells to be drilled at Khursaniyah was also planned for 1961. Together with other facilities, these installations were expected to boost Khursaniyah field's productive capacity from the current 95,000 bpd to 125,000 bpd by October 1962.

An 18-mile, 34/36 inch line was built in June 1960 between Qatif and Ras Tanura. This is the largest-diameter pipe line in Saudi Arabia. Together with a 5-mile, 30-inch transfer line between the Ras Tanura refinery and the marine terminal, these two lines increased Aramco's pipe line shipping capacity by about 300,000 bpd.

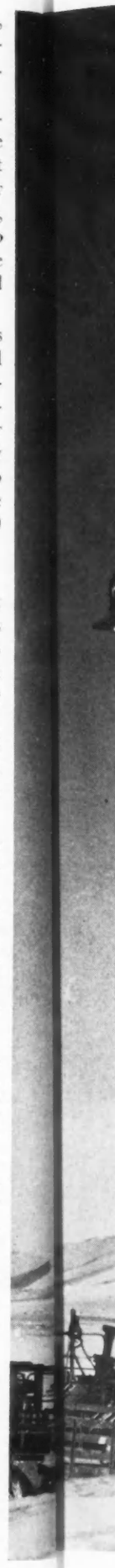
Abu Hadriya oil field is to be put on production next year. The field is located 100 miles northwest of Dhahran. It was found 20 years ago but development was postponed in favor of more prolific shallow fields. Initial production of 50,000 bpd is scheduled for October 1962. Aramco budgeted $2.35 million for facilities to start Abu Hadriya production.

Crude will flow from a two-stage gas separator to a heater, thence into a stabilizer to reduce the oil's hydrogen sulfide content enough to make it salable without further processing. These one-package facilities will represent the first combination gas-oil separator plant (GOSP) and stabilizer-pump station built by Aramco.

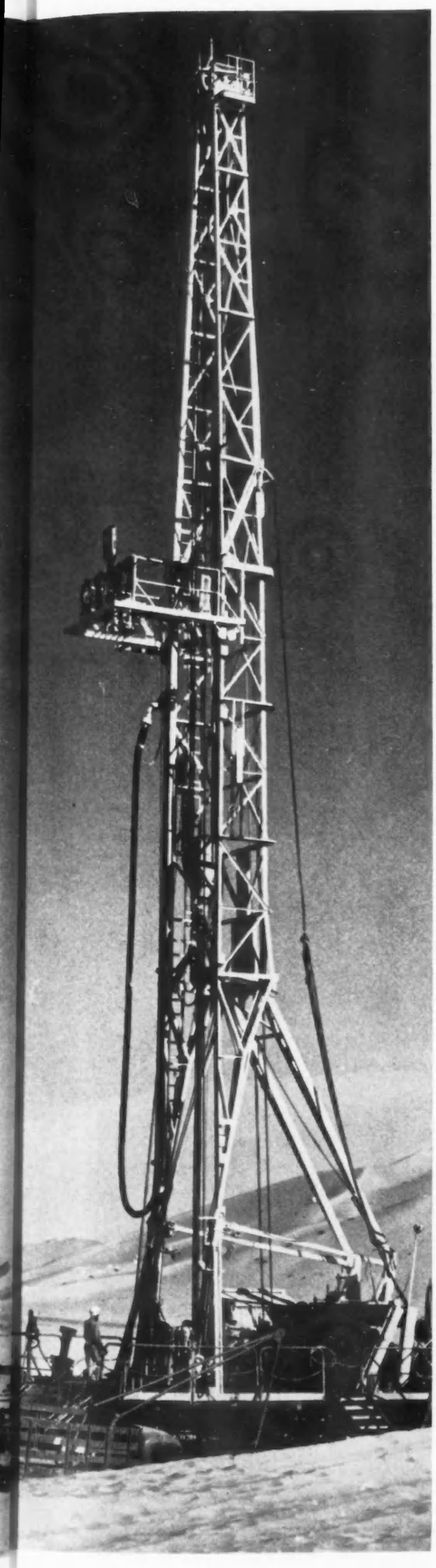
The plant will be located near the crest of the structure 36 miles southeast of Nariya and 3½ miles north of the Qatif-Qaisumah line, to which it will be connected via a feeder line. Stabilized Abu Hadriya crude will be commingled with others pumped to Sidon, Lebanon via the Trans-Arabian pipe line (Tapline).

As of May 1961, it was planned to produce seven wells at Abu Hadriya, from Arab A and B members, mid-Jubaila and Hadriya zones.

Aramco has budgeted $550,000 to increase productive capacity in the 'Uthmaniyah area of Ghawar field



A mobile structure drilling rig of the Arabian American Oil Company carries on exploration work in the sands of the Rub'al-Khali (Empty Quarter) in Saudi Arabia.



from 365,000 to 400,000 bpd by the end of 1962. Five-mile loops of eight-inch pipe line are slated for 'Uthmaniyah GOSP's 1 and 2, and two mile, 8-inch flow lines will connect two new wells to GOSP 3.

At Safaniya field, construction of new facilities to boost crude output capacity from 215,000 to 240,000 bpd was underway in April 1961. A new 16-mile, 30/32-inch loop was being added to the original Safaniya-Khursaniyah line. By early 1962 an additional 29 miles of 30/32-inch loop for the Safaniya-Khursaniyah line is slated for completion; also a new GOSP at Safaniya and an extension of the main offshore gathering line.

Pressure maintenance-secondary recovery programs by Aramco show considerable variety. They are yielding good results, and are extremely significant to ultimate oil recovery in Middle Eastern oil reservoirs. At Abqaiq field, pressure is being maintained by both gas and water injection, and a miscible phase injection is also underway at 'Ain Dar.

Construction was to be completed at Abqaiq this year on an $8 million LPG injection plant, designed to compress and liquefy for injection into 'Ain Dar oil reservoirs about 55 MMcfd of flare gas. This will provide about 37,000 bpd of LPG and will augment salt water and dry gas already being injected at 'Ain Dar.

At Abqaiq field, water injection averaged 255,968 bpd in 1960, almost the same as the 255,203 bpd rate of 1959. The producing horizon, the Arab zone D member at about 6,500 feet, was undersaturated at the time of discovery in 1940. Reservoir pressure from the start of production in 1946 had a characteristic solution-gas drive pressure decline, and the field showed serious signs of depletion by the mid-1950's. Early peak production of 600,000 bpd had dropped to 287,061 bpd by 1956, to 284,928 bpd in 1957 and to 243,373 bpd in 1958. The initial pressure of almost 3,400 psi at 6,500 feet dropped to 2,450 psi by 1954, when gas injection was begun in the crest of the structure. Pressure was thus essentially stabilized until water injection was started in 1957 on the north flank of the field. Since then, reservoir pressure has increased by about 100 psi.

Gas injection at Abqaiq continued in 1960 at a rate of about 154 MMcfd, and at about 85.6 MMcfd at 'Ain Dar.

Naphtha injection is being done in Qatif field. Last year 1,897,610 barrels of surplus naphtha from the Ras Tanura refinery was placed in Qatif producing formations both for pressure maintenance and for conservation of surplus product.

Crude oil movement. As shown in Table 2, an average of 1,239,947 bar-

TABLE 1—Crude Oil Production and Wells in Saudi Arabia in 1960 by Fields and Zones

Field and Zone	PRODUCTION IN 1960		WELLS AT END OF 1960							
	Total Barrels	Barrels Daily	Producing	Shut in or Standing	Observation	Injection	Suspended	Abandoned	Drilling	Total
Ghawar										
'Ain Dar			40	12	5	6[1]	1	2	...	66
Shedgum			14	1	2	...	...	1	...	18
'Uthmaniyah			32	11	3	...	1	2	...	49
Hawiyah			...	1	1	...	...	...	...	2
Haradh			...	7	1	...	1	...	...	9
Fazran[2]			...	3	2	...	...	2	...	7
Total Ghawar	261,418,062	714,257	86	35	14	6	3	7	...	151
Abqaiq	109,695,324	299,714	59	3	5	12[3]	...	2	...	81
Safaniya	66,273,664	181,076	20	15	2	...	...	...	...	37
Dammam	12,658,110	34,585	28[4]	3[4]	1	...	...	9[4]	...	41
Qatif	5,918,586	16,171	5	4	1	1[5]	1	1	...	13
Khursaniyah	489,427	1,337[6]	...	5	2	...	...	1	...	8
Abu Hadriyah	...	...	...	3	1	...	...	2	1	7
Fadhili	...	...	...	1	...	...	...	...	...	1
Khurais	...	...	...	11	1	...	...	2	...	14
Manifa	...	...	...	6	1	...	...	...	...	7
Four other Areas[7]	...	...	...	...	...	...	...	4	...	4
Total, 1960	456,453,173	1,247,140	198	86	28	19	4	28	1	364
Total, 1959	399,820,590	1,095,399	203	72	22	18	4	28	3	350

[1] All gas-injection wells. [2] Included as part of Ghawar in Aramco statistics, although mapped as a separate field. [3] Includes 3 gas-injection and 9 water-injection wells. [4] Includes 2 gas wells. [5] Product injection well. [6] Field placed on production October 5, 1960; produced total yield shown at left; 88-day production average was 5,562 bpd. [7] Dry holes at al-Alat, Jauf, Ma'aqala, and stratigraphic well.

rels daily of crude was run from field storage in Saudi Arabia last year. The percentage loaded into tankers at Ras Tanura increased from 40.2 percent in 1959 to 48.7 percent in 1960, while deliveries to Tapline dropped abruptly from 31.1 to 20.3 percent over the same period. The 1960 Tapline thruput averaged 243,800 bpd compared with 336,700 bpd in 1959. These figures emphasize the effect (both on loadings at Ras Tanura and on Tapline's thruput) of the extremely low prevailing tanker rates last year.

Crude movement to Ras Tanura tankage increased from 174,273 bpd or 16.0 percent of the total in 1959 to 224,895 bpd (18.1 percent of total) in 1960, as the refinery's thruput increased. Crude movement to Bahrain increased from 139,140 bpd in 1959 (12.7 percent) to 160,161 bpd in 1960 (12.9 percent of total).

TABLE 2—Crude Oil Run from Field Storage in Saudi Arabia in 1960

Destination	Total Barrels	Barrels Daily	% of Total
To tankers at Ras Tanura	220,929,108	603,631	48.7
To tapline facilities at Qaisumah	91,961,028	251,260	20.3
To Ras Tanura refinery tankage	82,311,486	224,895	18.1
To Bahrain via pipe line	58,618,817	160,161	12.9
Total, 1960	**453,820,439**	**1,239,947**	**100.0**
Total, 1959	398,930,867	1,092,961	100.0

Crude oil deliveries from Sidon, Lebanon via Tapline during the first five months of 1961 amounted to 53,041,864 barrels, an average of 351,271 bpd. Monthly thruput averages fluctuated in 1961 from a record and near-capacity 454,625 bpd during February to a low of 247,131 bpd during May. The January average was 385,063 bpd; March's thruput dropped somewhat from the February record to 418,788, followed by an abrupt decline in April to 257,731 barrels daily.

Drilling in 1960 and early 1961 was restricted to outlining Abu Hadriya, Ghawar, Khurais, Manifa, and Safaniya fields. There were 17 completions last year. Delineation wells included 2 drilled in Abu Hadriya, 6 in Ghawar, 2 in Khurais, 2 at Manifa and 4 at Safaniya. A well was completed for reservoir observation and possible water injection between Abqaiq and Ghawar fields.

Four delineation wells drilled in Safaniya field in 1960 showed it to be about twice as large as previously believed by Aramco. Further development drilling was planed. Two other offshore wells were also completed in Manifa field, one each on southwest and southeast flanks. Manifa, although not completely outlined, is known to be 16 miles long and 10 miles wide. Six reservoirs contain oil, the upper and lower Ratawi, and the Manifa zone and Arab zone A, B, and C members.

On December 20, the barge Queen Mary sank in a storm during preparations to drill Safaniya 39. Offshore drilling was suspended, but was expected to be resumed in mid-1961. The Queen Mary was refloated early in 1961 and relegated to offshore workover duty.

Aramco then bought an offshore drilling tender, known as ADT-1. It

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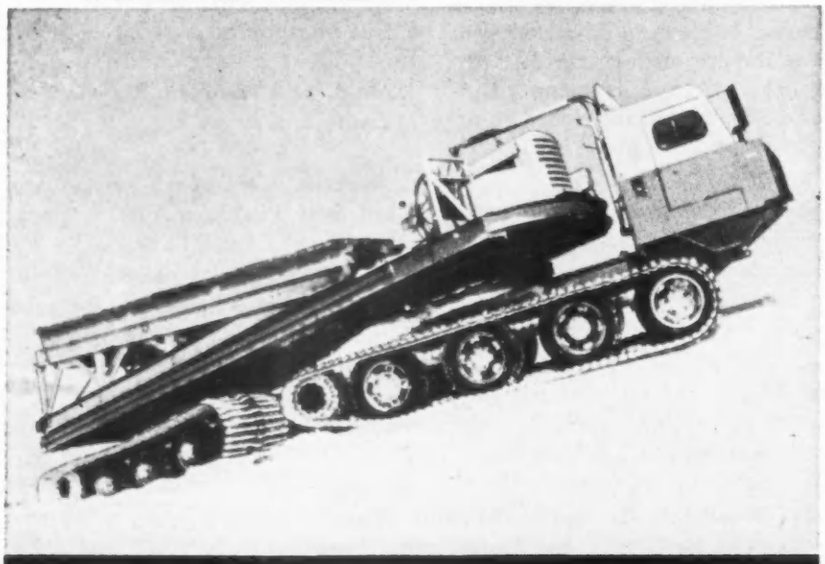

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307′ of 5″ liner then run to 12,612′ on drill pipe and cemented with 110 sacks neat UNAFLO. 40 sacks reversed out from above liner packer after it was set. Mud wt. 13 lbs./gal., visc. 50, water loss 3.1, log. temp. 232°F. Est. static B.H.T. 267°F. Top of liner held 5,000 psi test.

On the first squeeze job, 7″ casing perforated 11,824′ to 11,828′. Squeeze tool set at 11,750′. Formation breakdown occurred at 4,600 psi. 100 sacks neat UNAFLO mixed, 70 sacks out in formation under 6,000 psi, 30 sacks reversed from the well. Squeeze held dry test.

Second squeeze job saw 5″ liner perforated at 12,470′ to 12,505′. Drill-stem test showed gas and salt water. Formation breakdown at 5,600 psi. 100 sacks neat UNAFLO preceded by 500 gal. acid. 85 sacks forced into the formation under max. pressure of 7,100 psi.

Third squeeze job, same perforations. Formation breakdown at 5,000 psi. 100 sacks neat UNAFLO mixed with 76 in the formation under 6,900 psi. Zone failed to produce oil and well was completed in upper sand.

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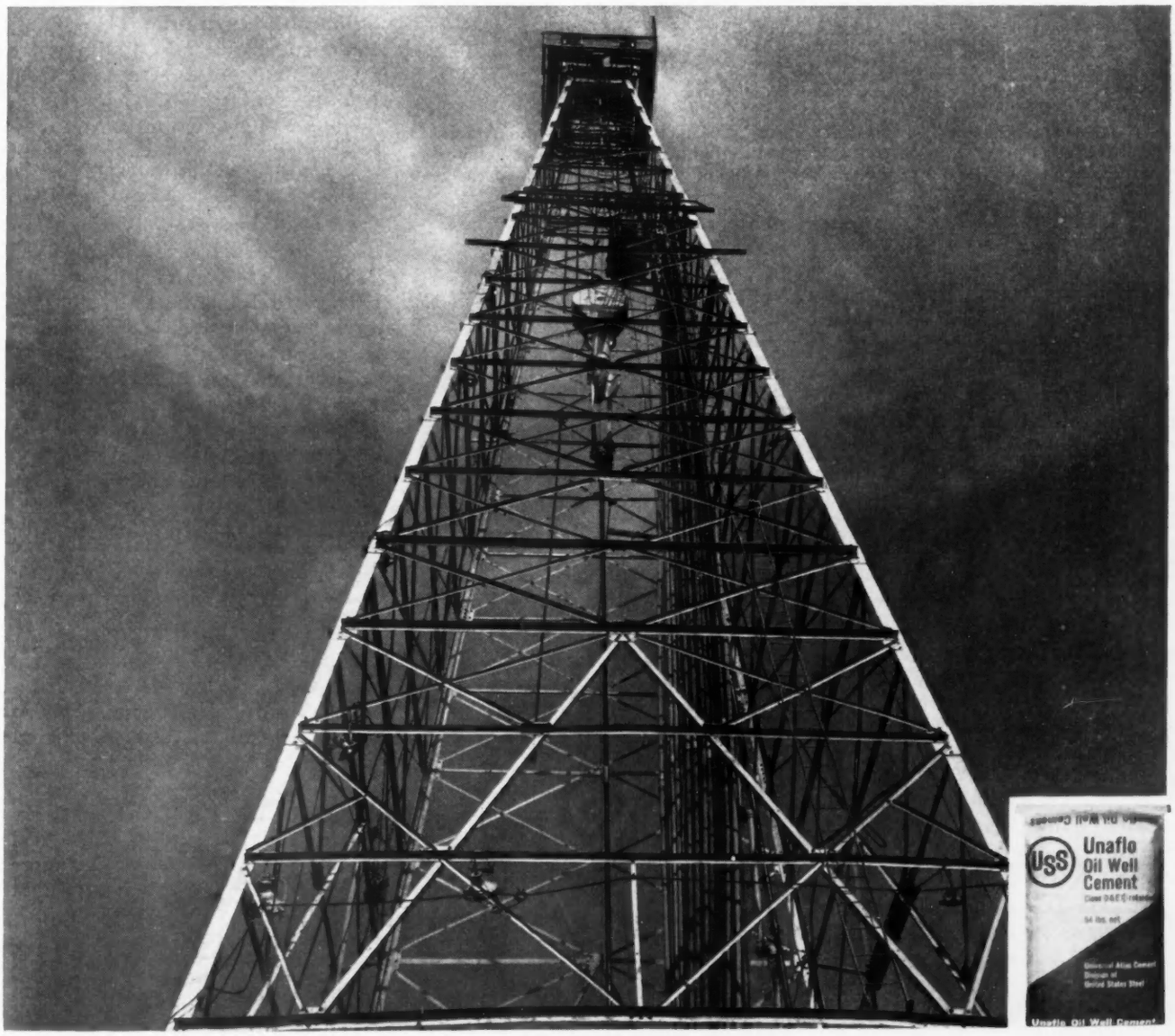

ACREAGE SITUATION IN SAUDI ARABIA

More areas are becoming available for future concession bids in Saudi Arabia as Aramco releases acreage in accordance with its original agreement. The large area relinquished in July 1960 stresses the importance of recent exploration in the Rub al-Khali.

was built in 1957 for Anson Drilling Company of New Orleans, La. It left the U.S. en route for Saudi Arabia on April 4, and, like the Queen Mary's former assignment, will work in conjunction with Aramco's three-legged mobile offshore drilling platform which was first put into service to drill Manifa 2 in 1958. Unlike the Queen Mary, the ADT-1 has a shaped hull designed for service in deep open water.

At Abu Hadriya, drilling was directed toward determination of limits of the Hadriya, Arab zone A, B, and C members and the mid-Jubaila zone. A drilling record for the field was set at Abu Hadriya 7, spudded last November 2 and completed January 6, requiring 66 days. Total depth was 9,550 feet, with oil being found in Arab zone members A and B. The previous well in the field, Abu Hadriya 6, bottomed at 10,800 feet.

At 'Ain Dar, outpost drilling continued last year. An east flank test was also drilled at Shedgum.

Two delineation wells were drilled at Khurais in 1960 to try to establish the north limit. At the end of December there were 11 wells capable of Arab-D member oil production, 2 dry holes, and one observation well at Khurais. The field was at least 40 miles long and more than 9 miles in maximum width.

As of April 1961, Aramco was working three onshore drilling rigs. One well was being drilled at Abu Hadriya and 2 at 'Uthmaniyah. One additional rig primarily intended for workovers but also capable of drilling new holes as necessary, was active.

Exploration. Although no purely exploratory full-hole drilling was done in 1960, exploration continued. Geological and geophysical work continued in remote regions of the Rub' al-Khali. Two seismograph crews and two structure drill parties were active. One structure-drill group, using two rotary rigs, worked the Abu Bahr-southern Summan area of the northwestern Rub' al-Khali before moving to the Tumaisha area in the far eastern section of the same vast desert region. Another structure drill crew, using heavier rotary equipment drilled stratigraphic-structure holes averaging 8,500 feet in depth on the southern and eastern edges of the Rub' al-Khali.

One seismic crew worked difficult terrain west of the sand mountains in the southern, central and eastern Rub' al-Khali. Continuous refraction surveys were run wherever the terrain permitted them. Refraction work in the Rub' al-Khali continued in early 1961.

Various geological studies continued, including regional facies, hydrological and polospore studies. Aramco is also trying to complete its part of its joint project with the U.S. Geological Survey to provide geologic and geographic map coverage of the Arabian Peninsula during the first half of 1961. The U. S. G. S. has published part of the proposed map coverage.

Relinquished acreage. On July 21, 1960, Aramco dropped 33,700 square miles in the southwestern part of the Rub' al-Khali, the fifth area to be relinquished under the terms of Aramco's agreement of 1948 with the Saudi government.

Crude oil reserves. Aramco estimated crude oil reserves in Saudi Arabia at the end of 1960 at 45.6 billion barrels. It was stated that reserves had increased by seven billion barrels during 1960, despite the record crude oil production last year. On June 13, 1960, Aramco produced its four billionth barrel of crude oil.

Factors which may have entered into Aramco's less conservative new reserves estimate are:

- The likelihood that Safaniya and Khafji fields are continuous, notwithstanding a report from Japan to the contrary
- The ability to maintain and at least partially restore reservoir pressure in such undersaturated Arabian reservoirs as Abqaiq through gas and water injection.

Refining. The Ras Tanura refinery processed an average of 224,894 bpd of crude last year, 29 percent more than the 174,273 bpd average thruput of 1959. Refinery runs during the first five months of 1961 averaged 254,106 barrels daily.

The Ras Tanura LPG plant, begun in September 1959, is to be completed

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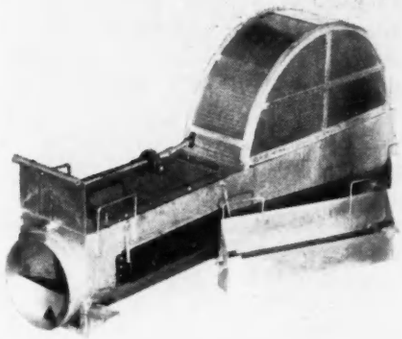

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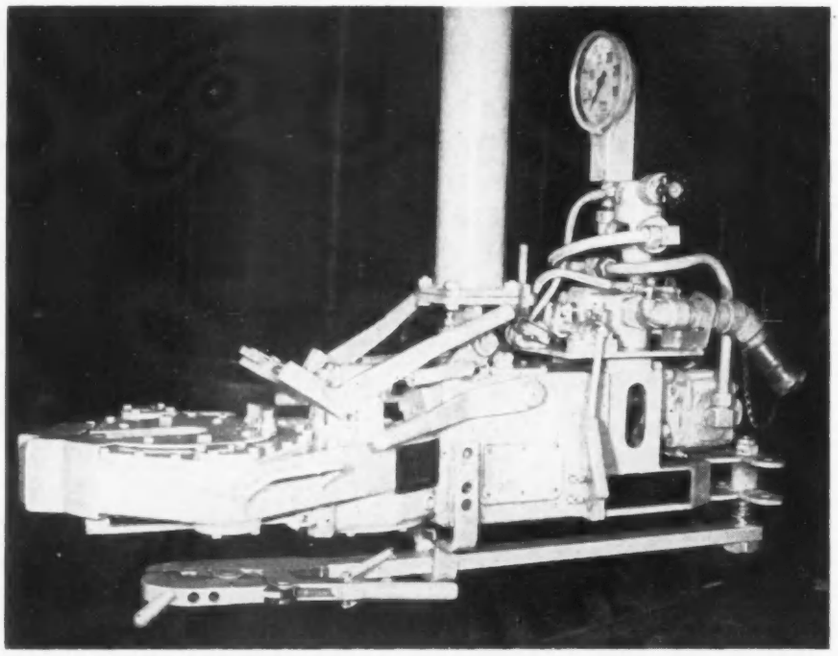
122

during the third quarter of 1961. It is designed to produce refrigerated butane, propane, or a blend of both, for tanker shipment. Cost of the new plant is estimated at $7.5 million.

New in-line blending facilities. In addition to the unique new refrigerated LPG plant, Aramco was completing elaborate blending facilities at Ras Tanura during mid-1961 to apply to different crudes and/or to blends of crudes and products. Five metering stations will be tied into at least two crude and product lines. When two such stations operate simultaneously the facility will be capable of loading up to 20,000 barrels hourly into tankers. This installation will have the world's largest in-line blending capacity. Since Ras Tanura is the main loading point in Saudi Arabia for both crude and products, a great variety of blends to be piped directly into tankers should be feasible in the future.



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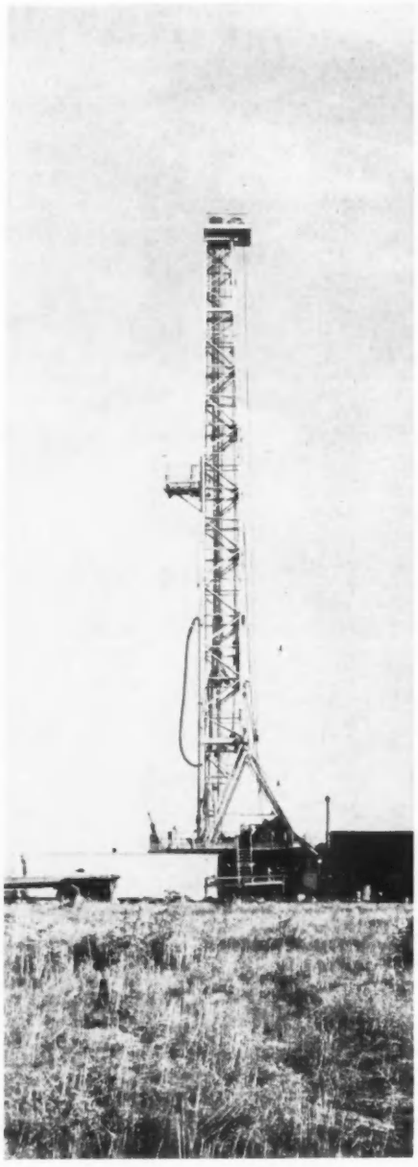


Photo Courtesy Standard Oil Co. (N.J.)

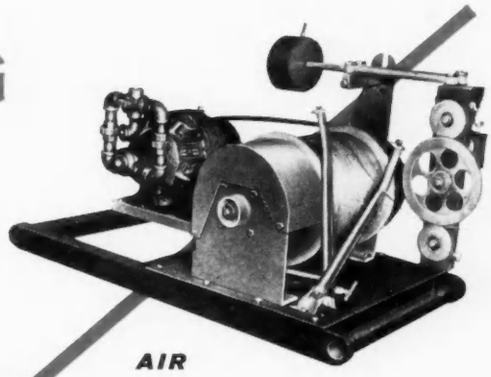
A wildcat being drilled in Thrace, about 100 miles from Istanbul near the Bulgarian border.

Turkey . . .

wildcatting increases

EXPLORATORY DRILLING in Turkey reached another new record level in 1960. Whereas all 19 wildcats completed in 1959 were dry, 11 of the 39 wells completed last year found oil and 1 reported at least a show of oil. Also highlighting oil activity in the country last year was the Mobil International Oil Co. discovery of 36-gravity crude in its Bulgardag 1, 40 miles inland from the port city of Mersin on the Mediterranean Coast. Mersin is the site of a 65,000-barrel-a-day refinery under construction, in

DOWNHOLE MEASURING VERSATILITY



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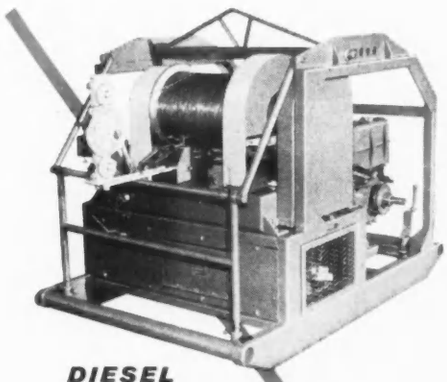

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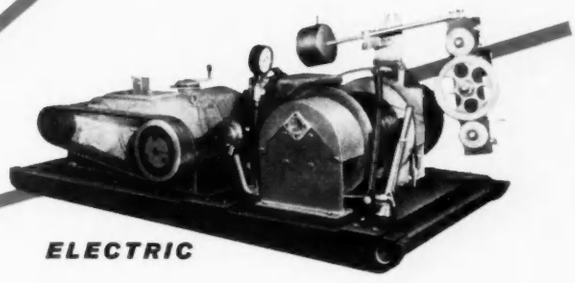

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DIESEL DRIVEN MEASURING . . . The diesel engine driven Super Duty Measuring Assembly serves in the toughest and most severe types of wireline operations. This complete package includes power . . . three-speed transmission . . . self-contained reel assembly . . . speed controls . . . measuring device . . . and wireline. The skid mounted assembly's convenient single point lift and rigid guard rails are ideal features for offshore platforms or any other heavy-duty wire line service.

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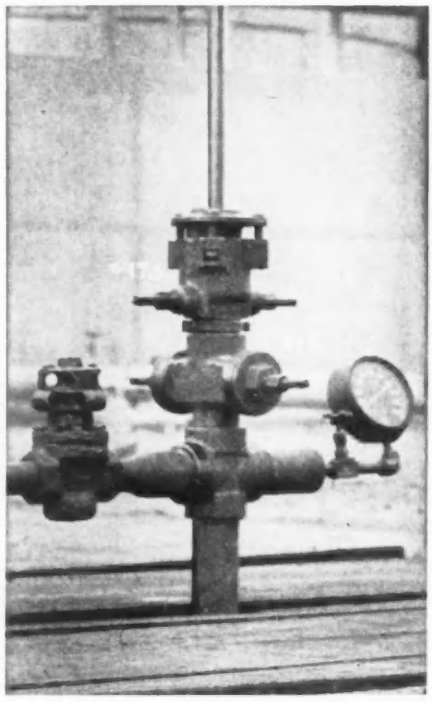
For more data on advertised products, use cards, last page.

TURKEY

TABLE 1—Production and Development Drilling in Turkey in 1960

COMPANY	Crude Oil Production		Crude Oil Producing Wells at End of Year				Field Wells Completed					Wells Drilling, Year End
	Total Barrels	Bbls. Daily	Flowing	Pumping	Total	Shut in	Oil	Gas	Dry	Total	Footage	
Turkiye Petrolleri AO	2,492,526	6,810	...	3	3	19	7	...	7*	14	73,946	1
American Overseas Petroleum Ltd.	80,948	221	...	...	...	3	...	...	...	...	.....	1
Mobil Exploration Mediterranean	.....	...	...	...	...	2	1	...	1	2	11,496	1
Total	2,573,474	7,031	...	3	3	24	8	...	8	16	85,442	3

* Includes 3 injection wells.



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The Ratigan No. 176 Stuffing Box and the Ratigan No. 212 Blowout Preventer, shown above, make an ideal combination for maximum safety and convenience in operation.

The No. 176 is designed so the polished rod is self-aligning, operating at maximum efficiency at all times. It is the only unit of its kind on the market that receives lubrication direct from the pumping well. Also the No. 176 can be "shut off" while repacking the box.

The No. 212 is comparatively light in weight, yet has 3000 pounds capacity. It is equipped with Ratigan's new type, quick changing retractable rubbers. In addition to its use as a blowout preventer, it also can be used for swabbing or running rods in wells that head or flow, in the course of operations.

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which Mobil holds a 56 percent interest.

During the first quarter of 1961, Mobil had completed its third producing well in Bulgardag field and had scheduled two exploratory tests in the vicinity of the new field. The discovery well, Bulgardag 1, was completed with an indicated productive capacity of 1,200 barrels per day; the third producer, Bulgardag 5, was completed with a producing rate of 640 barrels daily. Additional development and wildcat drilling to determine if reserves in the Bulgardag area will justify pipe line connections were underway in 1961. Mobil International, a division of Socony Mobil Oil Company, Inc., holds exploration licenses on almost a million acres in the area of the new field.

Production. Crude oil production, all from Asian Turkey, in 1960 amounted to 2,573,474 barrels, tantamount to a daily average of 7,031 barrels, as compared with total crude production in 1959 of 2,655,219 barrels, or a daily average of 7,275 barrels.

This output during 1961 came from the following oil fields, according to The American Association of Petroleum Geologists *Bulletin* 45, No. 7 (1961):

- Raman, with total production of 1,284,455 barrels, or 3,509 barrels daily.
- Garzan, with total output of 1,176,510 barrels, or 3,215 barrels daily.
- Germik, with annual production of 31,561 barrels, or an average of 86 barrels per day.
- Kahta, whose 80,948 barrels resulted from daily average output of 221 barrels.

Drilling. There were 39 well completions during 1960, of which 16 were development wells and 23 were exploratory tests. Including all tests reported as completed in 1960 and excluding footage of wells drilling at the end of 1960, a total of 235,142 feet of hole was tabulated for last year. About two-thirds of it was exploratory footage.

In 1959, there were 34 completions —15 development wells and 19 wild-

When portable electric power is vital, you can't afford to gamble on "accident prone" parts. Only Onan offers so many safeguards against breakdown: Stellite valves, oversize bearings, shorter-stronger connecting rods and crankshafts. Equally important, *only* Onan is Performance Certified to deliver *all* the power promised by its nameplate.

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TURKEY

cats. Hence, drilling increased last year, despite a lower level of activity or operations suspended by several companies. Wildcat discoveries by Mobil and Shell, both in carbonate reservoirs at moderate depths, provided some encouragement, though it remained to be seen whether these finds are commmercial.

Exploration. The oil discovery by Mobil at Bulgardag 1 mentioned in last year's report (WORLD OIL, August 15, 1960, Page 222) reversed a long dry spell in Turkish wildcatting. It was shortly followed by Turkse Shell Kayakoy 2, a wildcat located 27 miles northeast of Diyarbakir. On September 10, 1960, this well recovered on a preliminary test 22 barrels of 38° API gravity oil in 108 minutes from limestone at 5,798 feet. This formation was cased off and the well had been drilled below 11,300 feet in Paleozoic strata by the end of 1960. The well was being tested.

In Asiatic Turkey, according to the AAPG *Bulletin,* four of the companies active in Asiatic Turkey at year's end were responsible for a large portion of exploration activity. They were Mobil Exploration, N. V. Turkse Shell, Turkish Gulf Oil Co., and Turkiye Petrolleri.

Other companies active in Asiatic Turkey at year's end were American Overseas Petroleum Limited, Bolsa Chica Oil Company, D. D. Feldman Oil and Gas, Deilmann Petrol Ltd., Deutsche Erdol A.G., Panoil Co., Pauley Petroleum Ltd., and Tidewater Oil Company.

Total geological survey crew-months amounted to 75.2 in 1960, with Turkish Gulf accounting for 23.5 crew-months; TPAO, 14.3 crew-months; and Mobil Exploration, 12.4 crew-months. In Districts 2, 5, 6, 7, and 8, no magnetic studies were conducted last year; however, gravity party months totaled 0.7 month; simultaneous gravity/magnetic, 5.8 party months; seismic reflection, 26.9 party months; and seismic refraction, 5.5 party months.

In European Turkey, five companies were active at the end of 1960: American Overseas, Deilmann Petrol-N. V. Turkse Shell, Tidewater Oil, Turkish Gulf, and TPAO.

Drilling activities in this area, according to the AAPG *Bulletin,* included those of:

- Deilmann/Shell, which drilled three wells. Maltepe 1 was completed as a dry hole and abandoned early in 1960 at 7,805 feet in alternating volcanic and sedimentary rocks of possible Eocene age. Kuleli 1 was abandoned at 9,430 feet after encountering a show of light oil plus water between 8,800 feet and 9,050 feet in reef limestone of possible Eocene age. Kuleli 2 was plugged and abandoned at 9,570 feet after failing to find the reef limestone encountered in Kuleli 1.

- Turkish Gulf, which drilled two wells. Inecik 1 was plugged and abandoned at 5,212 feet in interbedded volcanic and sedimentary rock of possible Oligocene or Eocene age after encountering no shows. Eriklice 1 was abandoned at 4,550 feet in possible basement rocks without encountering any shows.

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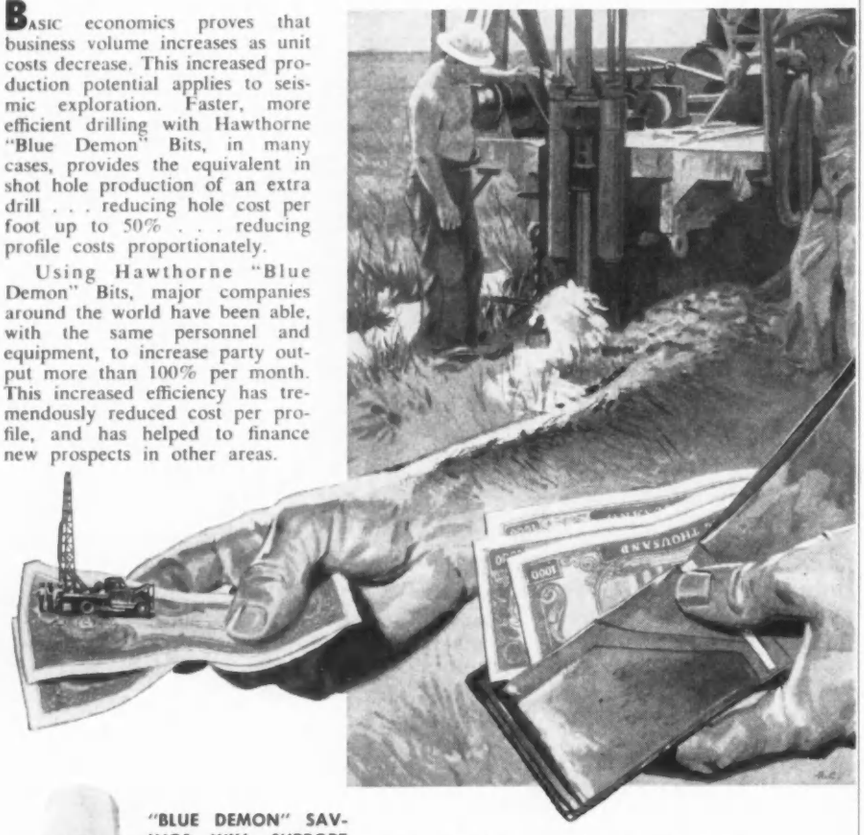
NEW BUSINESS CREATES NEW WEALTH

BASIC economics proves that business volume increases as unit costs decrease. This increased production potential applies to seismic exploration. Faster, more efficient drilling with Hawthorne "Blue Demon" Bits, in many cases, provides the equivalent in shot hole production of an extra drill . . . reducing hole cost per foot up to 50% . . . reducing profile costs proportionately.

Using Hawthorne "Blue Demon" Bits, major companies around the world have been able, with the same personnel and equipment, to increase party output more than 100% per month. This increased efficiency has tremendously reduced cost per profile, and has helped to finance new prospects in other areas.



"BLUE DEMON" SAVINGS WILL SUPPORT FUTURE DRILLING PROSPECTS

Drilling conditions will vary, but you can count on decreased costs per profile . . . increased party potential . . . in increasing crew efficiency with "Blue Demon" Bits.

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308

TABLE 2—Wells Drilled in Turkey in 1960

Company and Well	Depth (Ft.)	Results*
COMPLETED IN 1960		
Turkiye Petrolleri A. O.,		
Garzan 45	4,847	Oil
Garzan 46	5,122	Inj.
Garzan 47	8,227	Dry
Garzan 48	5,341	Dry
Garzan 50	5,169	Inj.
Garzan 51	5,438	Inj.
Garzan 30	5,002	Oil
Raman 36	409	Plg.
Raman 40	4,241	Oil
Raman 42	4,417	Oil
Raman 44	4,603	Oil
Boyabat 1	7,137	Dry
Bostakan 1	6,977	Dry
Gokviran 1	5,040	Dry
Ridvan 1	5,285	Dry
Sadik	4.602	Dry
Germik 2	7,218	Dry
Germik 3	7,363	Oil
Germik 5	6,550	Oil
N. V. Turkse Shell,		
Karadag 1	10,694	Dry
Kayakoy 1	229	T D
Deilmann/Shell,		
Maltepe 1	7,805*	P & A
Kuleli 1	9,430	P & A
Kuleli 2	9,570	P & A
American Overseas Petroleum Ltd., Vakiflar 1	12,321	Dry
Kahta 5	4,008	Dry
Esso Standard Turkey (Inc.), Tokaris 1	8,318	Dry
Kochisar 1	1,135	Dry
Kochisar 1A	8,635	Dry
Turkish Gulf Oil Co.,		
Incecik 1	5,214	Dry
Eriklice 1	4,549	Dry
Yona 1	5,461	Dry
Topalli 1	6,035	Dry
Mobil Exploration Mediterranean, Sinan 1	10,690	Dry
Dumandere 1	8,099	Dry
Bulgurdag 1	4,857	Oil
Cakit 1	3,608	Dry
Bulgardag 2	5,793	Oil
Bulgardag 3	5,703	Dry
Total, 39 Wells	235,142	
DRILLING DEC. 31, 1960		
Turkiye Petrolleri A. O.,		
Garzan 13	72	.....
Garzan 49	292	.....
Uluman 1	1,315	.....
N. V. Turkse Shell,		
Kayakoy 2	11,329	Testing oil shows

* Abbreviations: Inj, Injection; Plg, Plugged; P & A, Plugged and abandoned; TD, Technical difficulties.

A total of 16.3 party-months of geological surveys was reported in Turkish Thrace during 1960. Eleven party-months of geophysical studies resulted from 6.5 party-months of gravity operations, 3.3 party-months of sesimic activity and 1.2 party-months of gravity-magnetic studies.

Concessions. While 10 companies relinquished licenses during 1960, according to the AAPG *Bulletin*, three companies acquired licenses. A summary of these acquisitions follows:

Turkiye Petrolleri acquired four licenses in District 2, and one each in Districts 5 and 6, and 6 licenses in District 8, for a total of 12.

Pauley Petroleum acquired two licenses each in Districts 2, 7 and 8, for a total of 6.

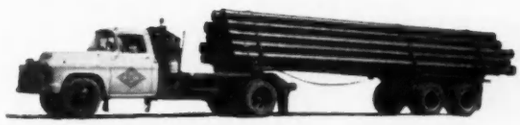
Turkish Gulf acquired two licenses in District 7 and one each in Districts 6 and 8, for a total of 4.

Congrats and $25.00 to Charles L. Mizer, 114 Lexington Ave., Taft, Calif.

Tough, tested and ready to roll . . . that's the story in a nutshell on Lone Star casing, tubing and line pipe. Tough, because it's made of quality steel by men who know the needs of the oil country. Tested so carefully that every length of pipe meets or exceeds API requirements before it leaves our plant. And because we're located in the heart of the Mid-Continent producing area, Lone Star pipe can usually be on-the-job at your well site overnight.

Men in the saddle in the oil business know that Lone Star pipe is *dependable*.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



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Abu Dhabi . . . Umm Shaif to produce

DEVELOPMENT OF THE NEW Umm Shaif oil field in the Persian Gulf continued according to schedule in 1960 and early 1961. Production is slated to begin by the second half of 1962. Umm Shaif 1 was completed during the summer of 1958 flowing 2,400 bpd of 40° API gravity crude from the lower Cretaceous Thamama limestone at about 5,500 feet. Since then oil has also been found in the Jurassic Arej limestone above 10,000 feet.

Abu Dhabi Marine Areas, Ltd., is the operator of the 12,000-square-mile offshore concession. The company is owned two-thirds by British Petroleum Company, Ltd., and one-third by Compagnie Francaise des Petroles.

By April 1961, five wells, all on the same structure, had been completed, and installation of production facilities was proceeding. Umm Shaif 4 bottomed in 1960 at 10,158 feet in the Arab zone (Jurassic). Umm Shaif 5 was drilling at 4,585 feet on December 31.

On March 2, 1961, it was announced that pipe had been ordered and a contractor selected to lay a 20-mile, 18-inch submarine pipe line from Umm Shaif to Das Island, 20 miles west of the field. The line will terminate at gas/oil separators on Das and crude will thence pass through flow tanks to the main storage tanks. From there it will be pumped to an offshore tanker loading berth through 26/28-inch line, about half of it submarine. Centrifugal crude loading pumps and generators will burn gas from the separators.

Construction of storage areas, an artificial harbor and the tanker berth had begun by early 1961.

pumps continuously...
800 bbls/day every day
at 1300 psi

Model KCA Triplex Reciprocating pump, made by the Worthington Corp., Harrison, N. J.

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salt water pump

MODEL VG4D
4-cylinder —
25 to 37 hp

Once started, this Worthington salt water disposal pump becomes an automaton. It works 24 hours a day, every day. To keep up the pace, the pump is powered by a heavy-duty air-cooled Wisconsin Engine that is tailored for the grueling job.

The rugged VG4D Wisconsin is built to stand up under continuous loads. It is precision-fitted to cut wear and upkeep. Its high torque enables the engine to slug through shock loads without stalling.

The air-cooled Wisconsin starts fast and runs smoothly in freezing cold and broiling heat. And you don't have to bother with water or anti-freeze — nor with radiators, water pumps, fan belts, and other water-cooling parts.

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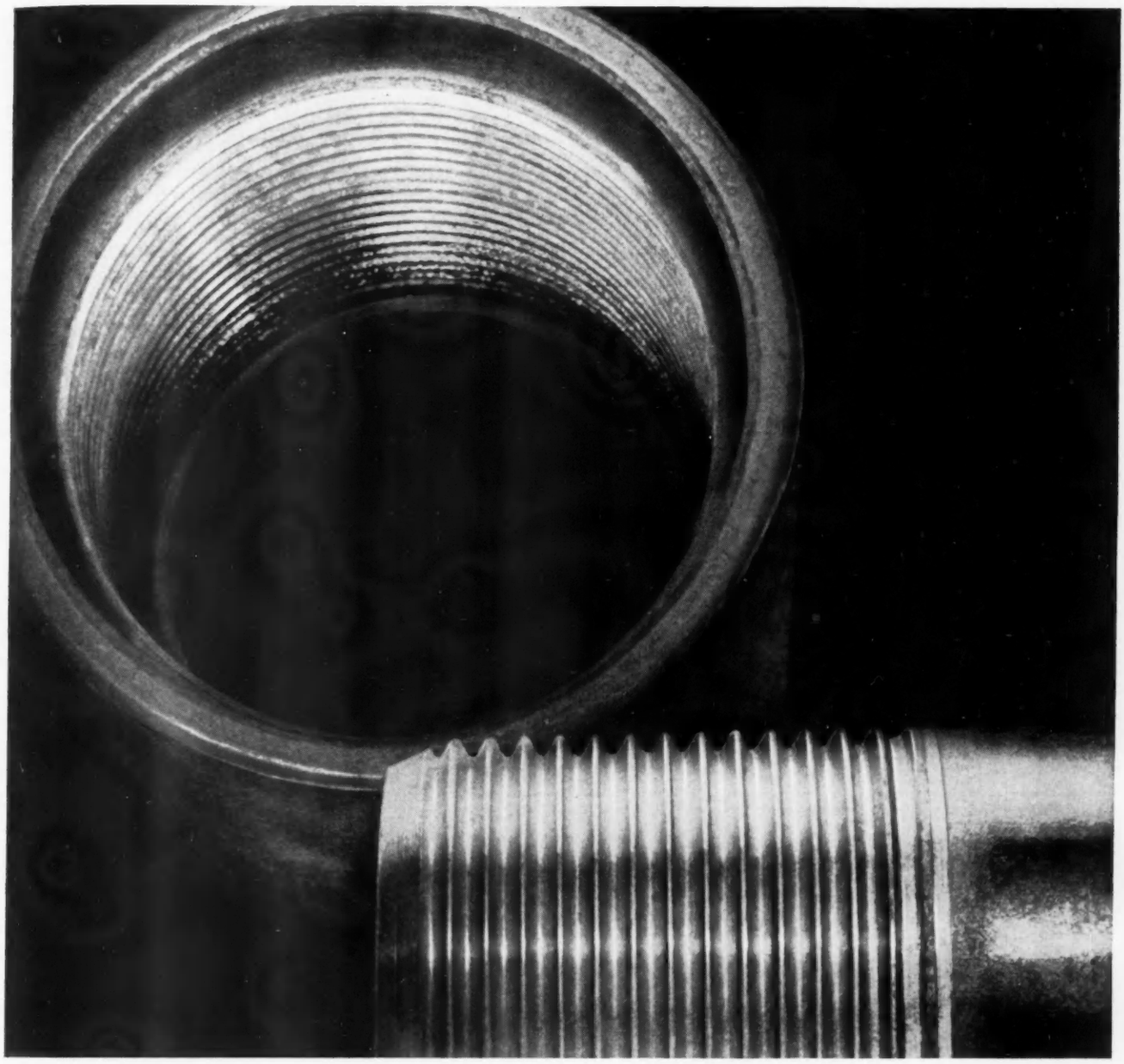
Aden . . . new firm seeks exploration rights

NEGOTIATIONS between Petroleum Concessions Ltd. (an Iraq Petroleum Co. affiliate) and the two governing sultanates in the Aden Protectorate were suspended in 1960 without an agreement for further exploration being concluded. The operating company did not report any activity last year. In mid-1961 Pan American International Oil Corp. was reported negotiating for exploration rights.

The Aden refinery, operated by BP Refinery (Aden) Ltd. charged an average of 85,002 bpd in 1960, up slightly from the 84,000 bpd average of 1959. Capacity is to be increased from 110,000 to 136,000 bpd by a $1.54 million expansion program to be finished by the end of 1961. Another 1961 development at Aden is the export of LPG which began in April.

Dhofar . . . more dry wildcats. Rigs idled

DHOFAR-CITIES SERVICE Petroleum Corp. completed six dry wildcats aggregating 40,340 feet of hole last year



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DHOFAR

on its 32,000-square-mile concession in the extreme southern part of the Arabian Peninsula. These wells were as follows:

Well	Total Depth In Feet
Jarf 1	9,647
Southwest Marmul 1	9,250
Arba 1	5,776
Suneik 1	4,350
Afar 1	5,678
Haluf 1	5,639

Janab 1 was reported drilling at 5,837 feet at the end of December. It was reported dry and abandoned at 7,400 feet in early 1961. Following this, operations were reported suspended pending a re-evaluation of the accumulated geological, geophysical and drilling data.

Hadhramaut . . . some seismic work done

A MINOR AMOUNT of seismic work was reported last year by Petroleum Concessions Ltd. (Hadhramaut), affiliated with Iraq Petroleum Co. and working a little known group of shaikhdoms on the southern coast of the Arabian Peninsula located east of Aden proper and west of Dhofar. The company reported 2½ party months of reflection and 1 crew month of refraction seismic work but no drilling last year.

Israel . . . new pays found; drilling increases

ACTIVITY QUICKENED in Israel in 1960 and 1961 as new pay horizons, both oil and gas, were found and previous oil production rates were maintained. Total footage, including full-hole and stratigraphic drilling amounted to more than 100,000 feet in 1960, a better than 50 percent increase over comparable 1959 figures. While crude oil production from Heletz and Brur fields remained about the same as in 1959, an upward trend was recorded in all phases of drilling activity.

Highlights of Israel's exploration activity during 1960 were:

- Extension of the Zohar gas field three miles to the north, and
- Discovery of oil in Negba 3, two and a half miles north of the Heletz-Brur oil producing area.

Throughout 1961, principal exploration trends were expected to be:

1. Continued development drilling in the Zohar-Kidod gas field and Negba oil field to define their limits.

2. Drilling of a number of smaller structures in the northern Negev, mainly in search for natural gas.

3. Continued search for stratigraphic traps in the Coastal Plain in formations of lower Cretaceous and Jurassic ages.

As of the first of 1961, six companies were actively engaged in exploration operations. Thirty-one licenses and one petroleum lease were

Producing Wells and Development Drilling in Israel in 1960

FIELD	Wells at End of 1960				Field Wells Drilled in 1960					Wells Drilling at Year End
	Producing			Shut In	Oil	Gas	Dry	Total	Footage	
	Flowing	Pumping	Total							
Heletz-Brur (Oil)	.....	24	24	1	2	..	1[1]	3	11,749	..
Zohar-Kidod (Gas)	.....	..	..	8[2]	..	3	..	3[3]	13,197	1
Negba (Oil)	.....	..	..	1	..	..	1	1	5,525	1
Total	.....	24	24	10	2	3	2	7	30,471	2

[1] Abandoned due to technical difficulties.
[2] Awaiting pipe line construction.
[3] Undergoing testing at year's end.

Exploratory Drilling in Israel in 1960

1. Full Hole Drilling

Operator[1]	Well	License	Spud Date	Completion Date	Total Depth, Feet[2]	Bottom in (Formation)	Remarks
INOC	Arava	4/7	6/14/59	5/11/60	[3]8,980	Neogene	Abandoned due to technical difficulties
LIOP	Nirim 1	2/22	5/22/60	8/11/60	7,770	Jurassic	Dry, minor gas shows
	Negba 3	2/8	7/29/60	9/1/60	5,523	L. Cretaceous	Oil from L. Cretaceous sands
	Nirim 2	2/22	8/26/60	11/21/60	7,731	Jurassic	Dry
	Qern 1	1/26	9/6/60	.....	7,945	.....	Drilling at year end
ICOC	Beersheba 1	2/25	1/1/60	8/17/60	9,180	Triassic (?)	Testing
NIPC	Daya 1	1/15	9/2/60	12/8/60	6,352	Triassic (?)	Testing

Total, full-hole exploratory drilling, 6 wells (excl. Arva) 44501.

2. Stratigraphic and Structure Drilling

Operator[1]	Well	License	Footage
INOC	Jaffe 1	2/21	7,677
	Fai 1	1/24	1,023
LIOP	Talmei Yaffe 1	2/8	3,240
	Talmei Yaffe 2	2/8	5,016
	Talmei Yaffe 3	2/8	5,504
IAOC	National Park 1	2/27	3,871
LIOP & NIPC	Mavkiim 2	2/16	3,423
IAOC & INOC	Kfar Azar 1	2/27	2,720
Total, stratigraphic and structure drilling (8 wells)			32,474
Total, full-hole and stratigraphic-structural exploratory drilling (15 wells)			76,975

FOOTNOTES

[1] Company names are abbreviated as follows:
INOC: Israel National Oil Co.
LIOP: Lapidot, Israel Oil Prospectors Corp. Lt
ICOC: Israel Continental Oil Co.
IAOC: Israel American Oil Co.
NIPC: Naphtha, Israel Petroleum Corp. Ltd.
INPC: Israel Negev Petroleum Corp.

[2] All depths are with reference to kelly bushings.
[3] As of Jan. 1, 1960, Arva had been drilled to 8,694 ft.

Crude Oil Production in Israel

Year	Barrels	Barrels Daily	% Diff.
1960	900,000*	2,459	—1.6
1959	912,500	2,500	40.4
1958	650,000	1,781	62.5
1957	400,000	1,096	164.9

* Estimated.

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OIL AND GAS FIELDS AND PIPE LINES IN ISRAEL

Oil production continues in Heletz-Brur field in Israel, and a wildcat oil discovery has been made at Negba 1. The new Zohar gas field near the Dead Sea appears to be encouraging, and means to utilize the gas are underway.

in force, covering almost 2¼ million acres.

Early this year, Lapidot Israel Oil Prospectors Corp. Ltd. acquired a controlling interest in the holdings of Israel Negev Petroleum Corp. Furthermore, the year has been marked by these farmout agreements,

- Israel National Oil Co. (INOC) and Israel American Oil Co. (IAOC) agreement to carry out a joint exploration program on their Coastal Plain Licenses Yarkon 2/21, Gezer 2/20, Ramle 2/27, and Yavne 2/13.
- IAOC—INOC acquisition of a third undivided interest each in the Beersheba License 2/25 (Israel Continental Oil Co.) for the joint drilling of the wildcat Beersheba 1.
- Naphtha Israel Petroleum Corp. Ltd.—INPC—INOC joint drilling of Daya 1 on the Arad License 1/15 (NIPC).

Zohar-Kidod gas field. A total of eight wells had been drilled in this field as of April 1961. Proven limits of the field were extended three miles north with the succesful completion of Kidod 1 and one mile south with the drilling of Zohar 5. Final limits of the field had yet to be established. The three wells completed last year—Kidod 1, Zohar 5 and Zohar 6—were being tested, but no estimates of productive capacity were reported.

In this field, natural gas occurs in Jurassic limestone at about 3,600 feet. Earlier wells discovered three productive zones. In Zohar 6 and Kidod 1 additional gas-bearing zones were found at greater depths than previously known. It is in these deeper zones that tests were being conducted.

Oil-impregnated sandstones below the natural gas zones, initially discovered in Zohar 1, also were found in Zohar 6. But efforts as of April 1961 to produce this oil had failed.

At the end of 1960, one well—Kidod 2—was drilling. Gas-bearing limestones had been penetrated, and the well was being deepened to examine the oil indications blow. Technical difficulties prevented the deepening of Kidod 1.

The Zohar gas field had not been produced as of April 1961, although a 6-inch pipe line was being built to an industrial plant on the Dead Sea, 16 miles away. Based on tentative reserves estimates and results of available production tests, it is believed that production of 9 MMcf to 10 MMcf daily can be sustained for 10

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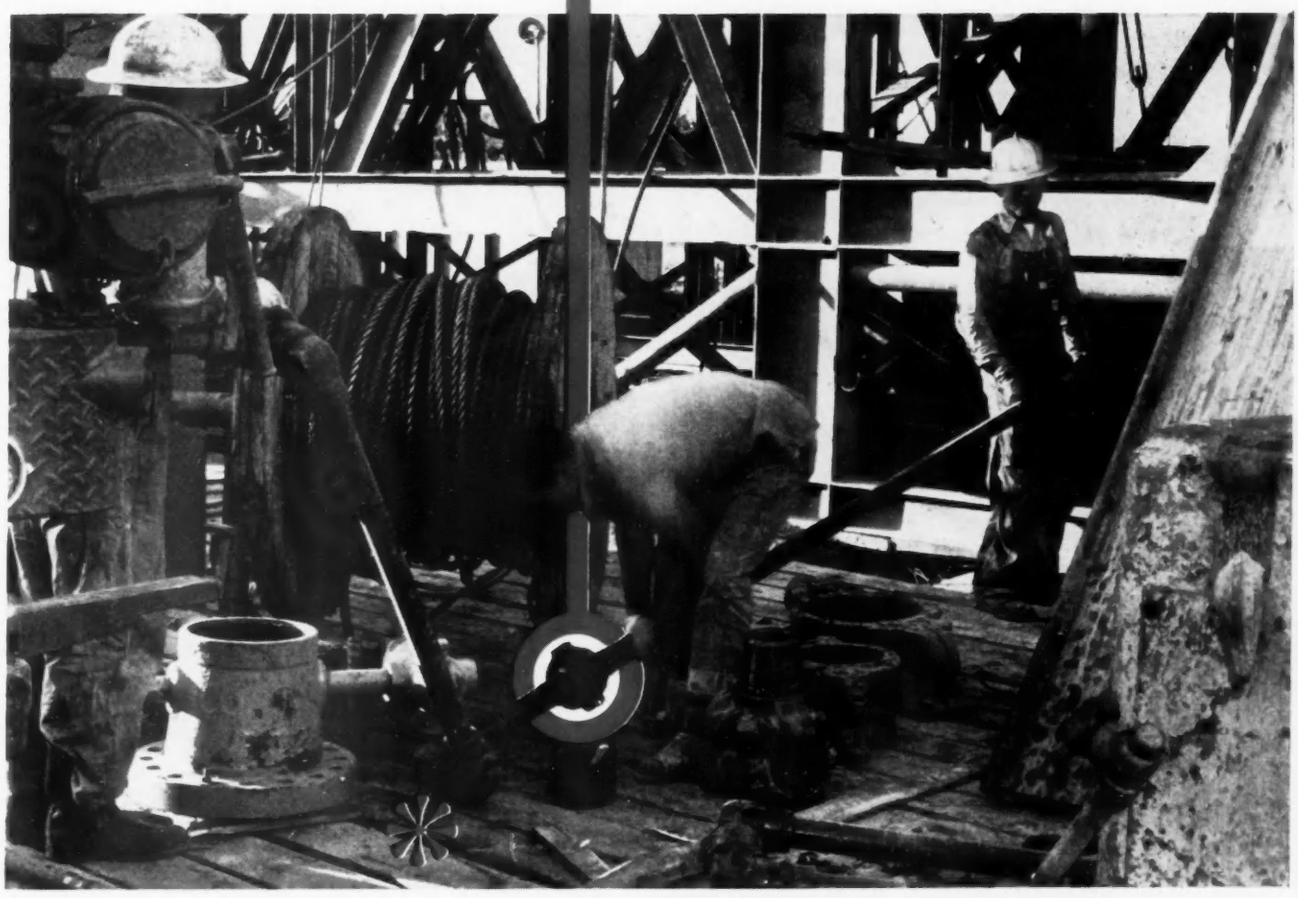

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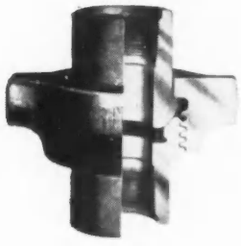

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to 15 years. More wells are planned to locate the north and east limits of the field.

Negba oil field. On Sept. 1, 1960, oil was discovered by Lapidoth Israel Oil Prospectors Corp. in Negba 3, two and one-half miles north of Heletz-Brur oil field. Two earlier wells were dry, and the area had been considered non-productive.

Since the completion of Negba 3, two wells have been drilled, Negba 4 and 5. Both were dry. At year's end, Negba 5 was being deepened to the Jurassic.

Of special importance is the fact that Negba 3 found oil in lower Cretaceous horizons other than those from which Heletz-Brur wells produce. This has led to a reappraisal of the oil prospects of the entire Coastal Plain where updip pinchouts of lower Cretaceous sands may occur.

In initial production, Negba 3 produced at a daily rate of 60 to 70 barrels. The well was shut in because of an increase in water.

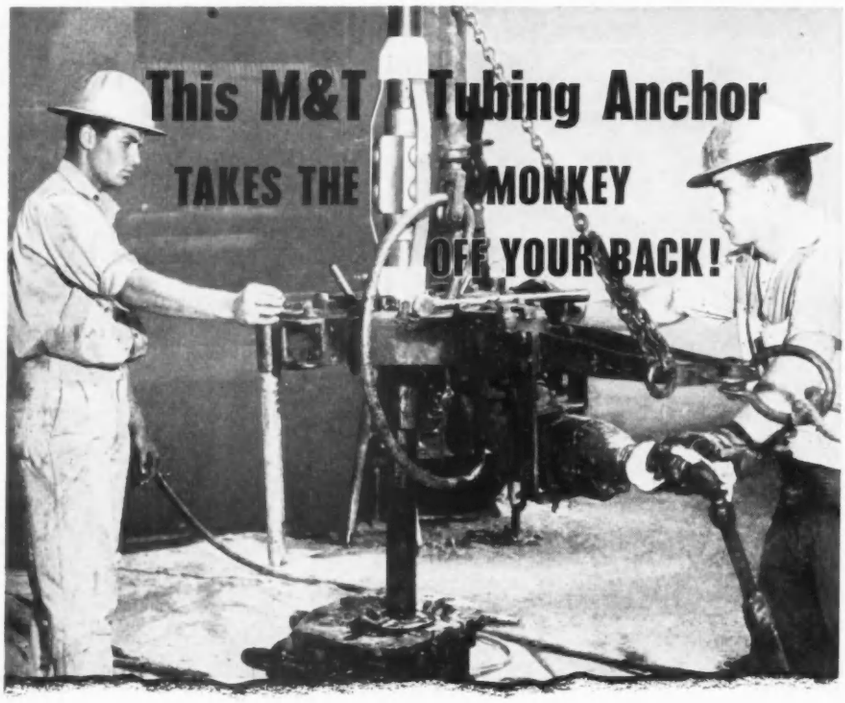
Heletz-Brur oil field. During 1960, the northern limits of the Heletz-Brur field were extended with the successful completions of H25 and H26. Thirty-three wells have been drilled in the field of which 24 are producing.

By the beginning of 1961, cumulative production for the field amounted to 3 million barrels, with more than 900,000 barrels having been produced during 1960. Tentative reserves estimates put ultimate recovery by primary methods at about 15 million barrels. Current daily production amounts to 2,800 barrels. All wells are being pumped, and average bottom hole pressure is 1,480 psi.

Other exploration. The search for shallow Neogene gas was continued in the Coastal Plain with the drilling of four wells last year. Though no gas was found, results of the National Park drilling were considered encouraging. Drilled in an area where subsurface stratigraphy was generally believed known, a Neogene sequence was found in this well which was different in lithology from that elsewhere in the vicinity. Presence of conglomerates provide new potential gas reservoir targets.

Seismic studies last year were concentrated in the Southern Coastal Plain. About nine field months of seismic reflection work was conducted in the Nirim, Negba, Gilat, and Gan Yavne areas. Experimental shooting, using magnetic tape recording, succeeded in obtaining continuous reflections in areas heretofore classified as poor or without reflection.

A gravity survey was completed in early 1960 covering about 250 square miles of the northen Negev region east of Beersheba. A number of subsurface structures were indicated by gravity in the Kuseife-Dimona area which may prove promising in view of the nearby Zohar-Kidod natural gas discoveries.



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Jordan . . . activity stops after six dry holes

INTEREST IN JORDAN'S OIL prospects waned in 1960 as Phillips Petroleum Co. released its 8,140,000-acre concession late in the year. Phillips'

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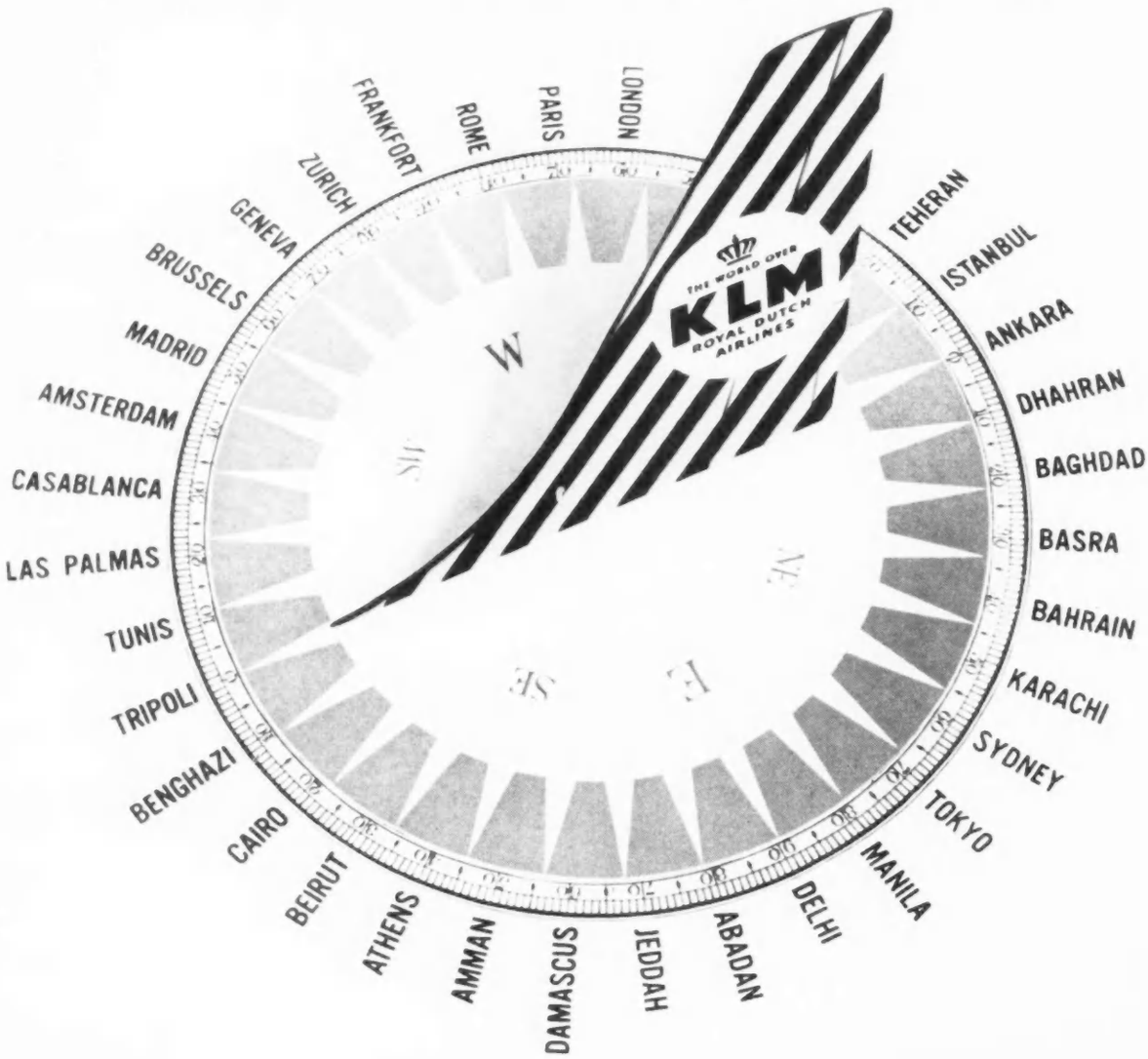

last well, El Lisan 1, near the Dead Sea about 25 miles west-northwest of Kerak, was drilled last year on a core drill and gravity prospect to 12,040 feet and abandoned. This was the sixth full-hole wildcat, all dry, drilled in the concession area since Edwin W. Pauley received it early in 1956. The original concession included all of Jordan. Pauley relinquished two-thirds of the original area before Phillips became the operator.

Early in 1961 Aero Service Corporation of Philadelphia, Pa., commenced an aerial photographic survey of 30,000 square miles of previously unmapped territory in eastern Jordan. Purposes of the survey include future petroleum studies. It is being done for the Jordanian government and financed by the U.S. International Cooperation Administration. Delivery of topographic maps, on a 1:50,000 scale, is scheduled for 1963.

Jordan's first refinery was formally opened on February 2, 1961. It is operated by Jordan Petroleum Refinery Co. Location is at Zarqa, north of Amman. Trans-Arabian Pipe Line Co. (Tapline) built an unattended metering station at km 1035 west of Qaryatain to allow Jordanian royalty crude to flow through a new 27-mile, 8-inch pipe line spur to the new plant. Tapline's deliveries started in August 1960; they average 5,000 to 5,600 bpd and will not exceed 11,000 bpd.

Lebanon . . . interest dimmed by dry holes

COMPAGNIE LIBANAISE DES PETROLES' 75-year concession covering about 1,900 square miles was expected to be dropped following completion of two dry wildcats.

German interests (Gewerkschaft Elwerath and Deutsche Schactbau) had acquired 50 percent interest in the acreage and conducted exploration, which was stopped in 1961.

A dry hole in the Bekaa Valley was reported drilled last year to about 8,400 feet, and a more recent test in southern Lebanon reportedly reached 7,000 feet.

Oman . . . venture has lost some partners

PETROLEUM DEVELOPMENT (OMAN) LTD., formerly affiliated with Iraq Petroleum Co. (IPC) abandoned the wildcat Haima 1 at 11,504 feet in February 1960, a depth which had been reached by the start of the year. It also plugged the Afar 1 wildcat two months later at 4,749 feet.

Petroleum Development (Oman) has since ceased its IPC affiliation, and is now owned 83 percent by the Royal Dutch Shell group. Shell Co. of Qatar, at least temporarily, will be responsible for operations management and services.

Petroleum Development (Oman) reported 3 party months of geological survey, 3 of seismic reflection, and 1½ crew months of gravity work through mid-April in 1960.

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Trucial Coast .

Murban oil field confirmed

APPRAISAL OF THE Murban structure, where the first test blew out in 1953 and later was junked, continued in 1960 and 1961. Petroleum Development (Trucial Coast) Ltd., an IPC affiliate, was drilling Murban 3 at the start of 1960, and found several interesting oil shows below 8,400 feet. Tests to evaulate these shows continued most of the year, and Murban 4 and 5 were also spudded. The company listed 2 completions, both oil wells, and a total footage of 18,886 feet last year.

These wells are widely spaced. Murban 2, drilled in 1959, is reported as a gas/oil observation well, and Murban 5 as an oil/water observation well. Murban 3, on the west, and Murban 4 on the north side of the field are believed to be good oil wells.

PD(TC) reported 12 party months of seismic reflection and 5½ crew months of gravity work during 1960.

Afghanistan . . . gas discovery reported. New oil law adopted

SOME TANGIBLE PROGRESS is being made to develop an oil industry in Afghanistan. Significant amounts of crude oil have apparently been found in the Turkoman Basin, north of the Hindu Kush mountains and south of the Russian border. Emphasis is being placed on evaluation of the extent and quality of crude oil deposits. The question of whether to build a small refinery to fulfill Afghanistan's small petroleum products demand (about 1,450 bpd) or instead to swap crude oil for Russian products, is being discussed.

Exploration. Official information released by the Afghan government relates to progress during the first five-year development plan which began in September 1956. During the first three years ending in September 1959, three oil wells aggregating about 12,500 feet of hole were drilled. During the fourth year ending in September 1960, considerable additional crude oil and natural gas deposits were found. An area of about 28,000 square miles was delineated for oil prospecting and for geological map coverage. A laboratory was established in Mazarisharif to analyze various crude oils.

Aerial magnetic coverage of a 16,000 square mile area in North Afghanistan has augmented geological coverage. The second phase of seismic operations and the preparation of geological maps on a 1/50,000 scale have been completed. New drilling equipment has been procured.

Aerial photographic coverage of the entire country, conducted by Russian technicians in the extreme northern border strip and by Fairchild Aerial Surveys, Inc., in the rest of Afghanistan, has been provided. The Afghan Geological Survey Institute has more than 100,000 aerial and ground photos which are being processed systematically. Oil exploration was said to be under way also south of the Hindu Kush.

Early in 1961, a gas discovery was announced by Soviet news sources. The discovery was reported at about 5,300 feet of depth at a northern border strip locality called Hodja-Gugerdag.

Petroleum law. Since January 1960, new Afghan laws to regulate the rights and duties of companies conducting exploration and exploitation of oil and gas (among other natural resources) have been effected. Stated purpose of the new legislation is to encourage local and foreign investors to enter this extremely important field. It was believed that the oil law is similar to legislation proposed by Dr. Ralph L. Miller and David Cerkel of the United States Geological Survey pursuant to their visits to Afghanistan in 1958, although some modifica-

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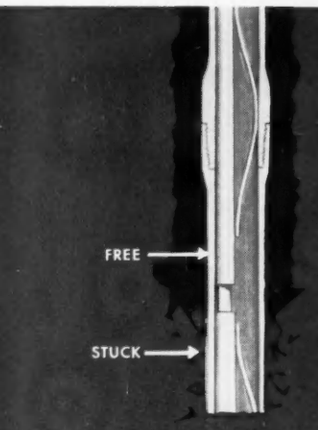

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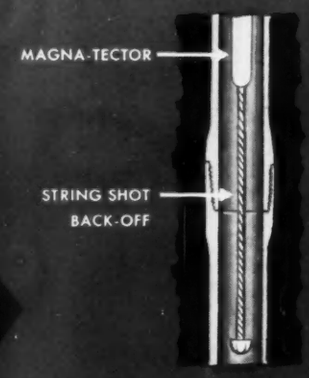

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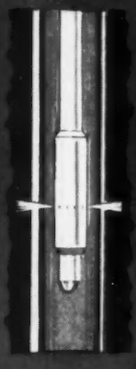

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tions were expected prior to final adoption of the law.

Iranian products imports. Last December the Afghan and Iranian governments made an agreement whereby about 17,000 tons (about 125,000 barrels, or about 350 bpd) of Iranian products will be trucked to Afghanistan annually. The first shipment left Meshed in northeastern Iran in February 1961. It consisted of about 180 barrels of benzine and about 90 barrels each of kerosine and gas oil. The deal specifies sale by Iran of these three products. The new storage depot at Harat, located 62 miles inside the Afghan border, is the delivery point. This new distribution arrangement supplements an earlier one built by the Soviets. A Russian-built products line crosses the Oxus River and serves four storage points, Kilift on the Oxus, Mazir-I-Sharif, Herat and Kabul.

Afghanistan is trying to stay neutral in the cold war, but is handicapped in petroleum matters since the only convenient market for its crude is Russia.

PETROLEUM DEVELOPMENT IN AFGHANISTAN

Map of Afghanistan shows the location of an oil discovery reported in mid-1960 by Russian diplomatic sources, near the town of Aq Shah. Previous tests at Sar-I-Pul, about 75 miles southwestward, encountered oil and gas shows. Northern Afghanistan is closed to geodetic work by western interests by an Afghan-Soviet treaty of 1929, forbidding work by foreign interests in border areas that could be construed as espionage. South of the border zone, aerial photography has been completed. Ground control was provided by Shoran triangulation stations shown, located on mountain tops.

OIL AND GAS FIELDS OF WEST PAKISTAN

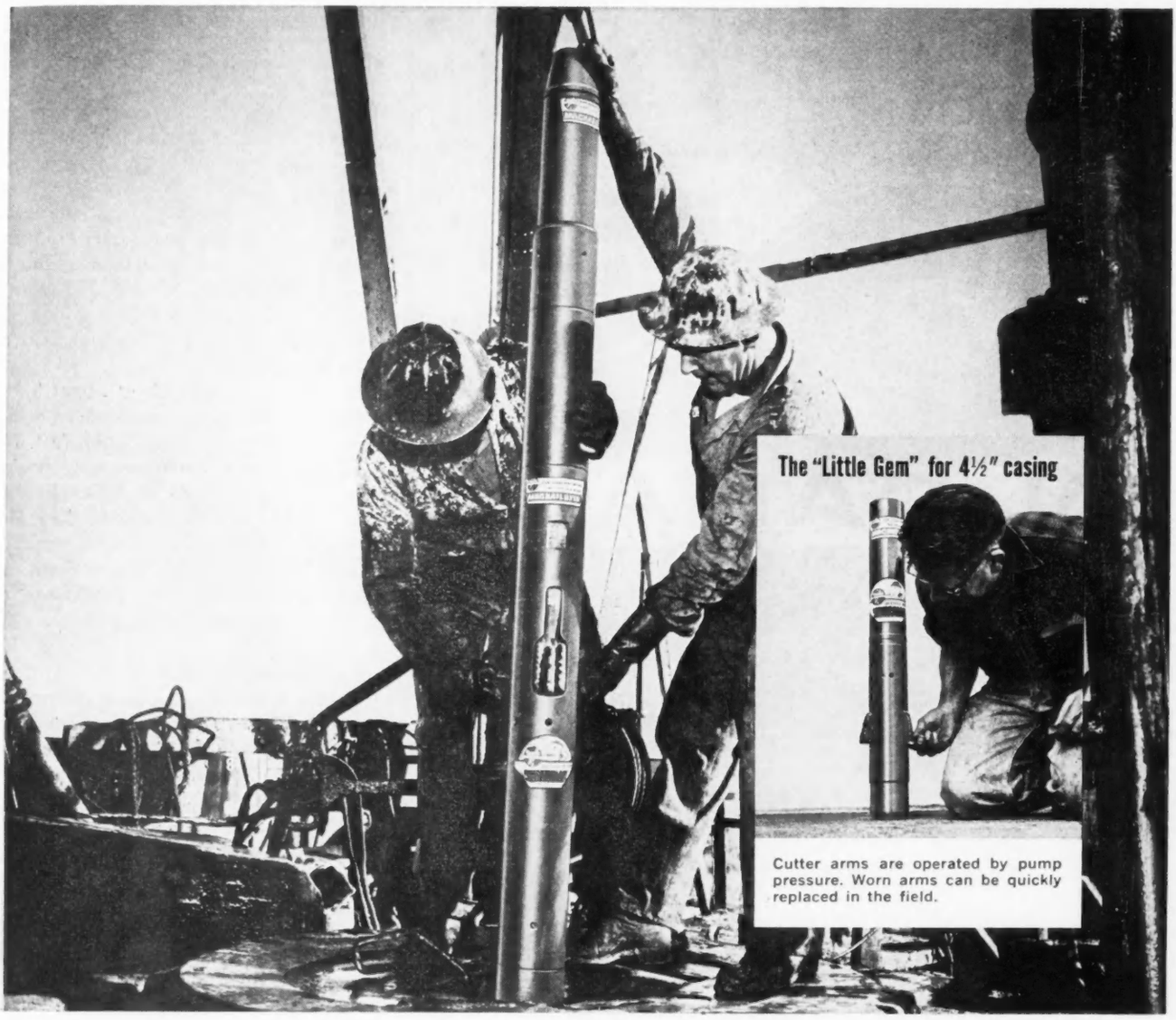
West Pakistan's industrial economy is continually being based more heavily on gas from Sui field, where productive capacity has been doubled. Gas pipe line extensions northeastward as far as India are proposed. In the Potwar Plateau oil-producing region, Jurassic possibilities are enhanced by Attock Oil Co. Dhulian 39, completed for 1,250 bpd from Jurassic limestone at 9,048 feet. Previous production has been from younger strata.

Pakistan . . . Sui gas output capacity increased. New oil pay discovered at Dhulian field

PAKISTAN'S OIL AND GAS industry made good progress in 1960 and 1961 within previously-established exploration and production patterns. Significant new oil reserves were found on the Potwar Plateau of northwest Pakistan, still the nation's only oil province. Gas reserves in the Sui field area of West Pakistan were increased; and a third gas field was indicated in East Pakistan, where limited commercial gas production began in July 1960.

These salient facts are stated in more detail as follows:

- Attock Oil Co. Ltd. completed Dhulian 39 at 9,106 feet for 1,250 barrels of oil daily from Jurassic limestone topped at 9,048 feet. This is a new pay in the area, and considerable acreage is newly enhanced for Jurassic possibilities. Dhulian field was found in 1937 on a broad open dome. Most early production was from the Eocene at 7,700 feet. Dhulian was the most productive oil field in the country last year. Dhulian 41 was being drilled at the end of December, and had reached 9,285 feet by March 1961.
- A seventh gas producer, Sui 7, was drilled by Pakistan Petroleum Ltd. (PPL) in Sui field and completed at 4,450 feet total depth. Sui gas purification capacity was doubled from 74 to 148 MMcfd last year. West Pakistan's reserves of pipe line quality gas were put at more than 8 trillion cubic feet, including more than 5 trillion at Sui field.
- In East Pakistan, Chhatak gas field, discovered by PPL in 1959, began delivering small quantities of gas to a cement works 12 miles away in July 1960. Offtake in 1961 was expected to rise to 5 MMcfd. PPL's Sylhet gas field, discovered in a violent blowout and fire in 1955 and



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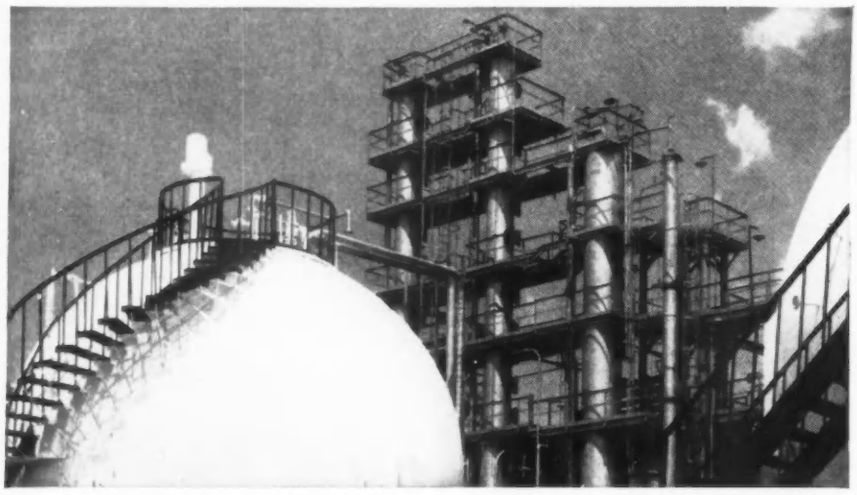

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PAKISTAN

confirmed by a second, successful test in late 1956, was slated to produce gas in 1961 for use in a fertilizer plant at Fenchuganj. A 27-mile, 8-inch line has been built to move the gas.

• East Pakistan's third gas field was indicated last year when Pakistan Shell Oil Co. completed Rasidpur 1 at a location at 24° 18′ 32″ North latitude, 91° 36′ 27″ East longitude in the Sylhet district 200 miles north of Chittagong. Dry gas was tested in two Miocene sands at about 9,000 feet and in a shallower zone at 4,550 feet. Total depth was 12,663 feet. No oil was found. An offset test, Rasidpur 2 was drilling at 9,143 feet in search of deep oil at the end of December. This second well reached 15,071 feet in 1961, deeper than any other hole in the Free World east of Africa. Testing was underway.

Crude oil production. As shown in Tables 1 and 2, crude oil production increased by 25.7 percent from 5,736 bpd in 1959 to 7,211 barrels daily in 1960. Minor yields from Joya Mair, Khaur and Karsal fields augmented production at Dhulian and Balkassar.

The Karsal 3 well, completed late in 1959 by PPL, has been disappointing. By late 1960 the well was producing only 35 bopd on a 7/16-inch choke. Karsal field production in 1960 amounted to 23,042 barrels. Karsal 4 well has been drilled to

TABLE 1—Oil and Gas Production, Producing Wells, and Drilling in Pakistan

Crude Oil Production, Barrels	
Total in 1960	2,639,204
Total in 1959	2,093,622
Daily Average in 1960	7,211
Daily Average in 1959	5,736
Percent Increase	25.7
***Natural Gas Production, in Thousand Cubic Feet**	
Total in 1960	23,025,516
Total in 1959	17,414,220
Daily Average in 1960	62,911
Daily Average in 1959	47,710
Percent Increase	31.9
Oil Producing Wells at End of Year	
1960, Total Wells	79
Flowing	31
Pumping	48
1959, Total Wells	90
Flowing	25
Pumping	65
Gas Producing Wells at End of 1960	**7**
At End of 1959	6
Wells Completed During Year	
1960, Total Wells	11
Oil	1
Gas	2
Dry	8
1959, Total Wells	9
Oil	1
Gas	3
Dry	5
Footage Drilled in 1960	**110,000**
Drilled in 1959	87,048
Wells Drilling at End of 1960	**3**
At End of 1959	4

* Raw gas offtake from Sui field only. Does not include gas production from oil wells. Also neglects small gas sales which started in July 1960 at Chhatak field in East Pakistan.

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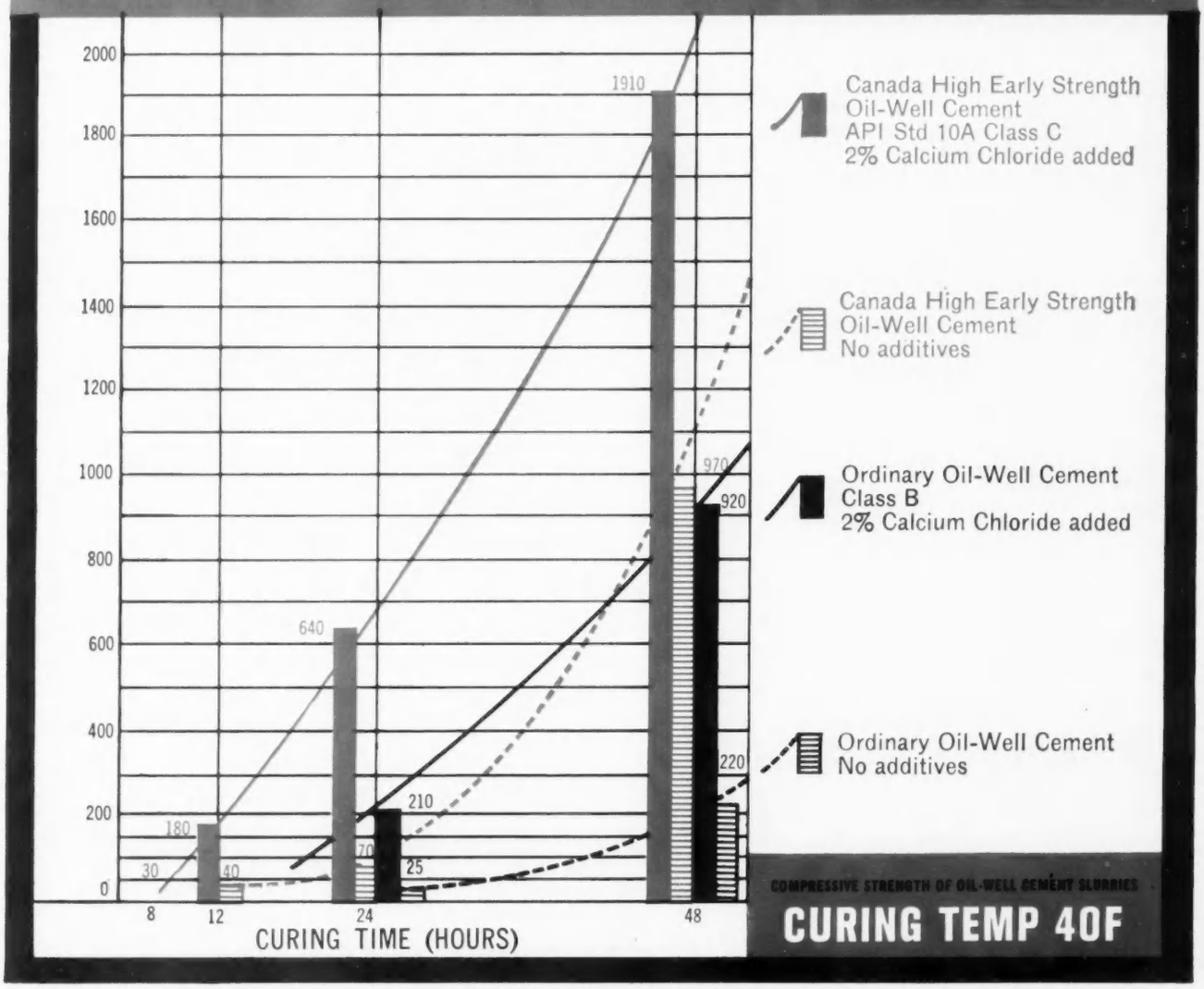

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12,222 feet but is likewise described as disappointing.

Natural gas production. Raw gas offtake from Sui field amounted to 23,026 MMcf last year, an average of 62,911 Mcfd, a boost of 31.9 percent above the 1959 daily rate of 47,710 Mcf. Offtake at Sui is expected to reach 28 billion cubic feet this year (76,712 Mcfd), or about 14 million more daily than in 1960.

Natural gas transmitted to Karachi via 16-inch pipe line amounted to 10,741 MMcf last year, and is expected to reach 11.5 billion in 1961. Thruput to Rohri, Khairpur, Hyderabad and other consuming centers south of Sui outside of Karachi, amounted to 5,732 MMcf in 1960, and may reach 6.3 billion this year. Shipments of pipe line gas northeastward to Multan amounted to 3,875 MMcf last year and are expected almost to double to 7.4 billion in 1961. As expected, transmission from Sui northeastward almost quadrupled in 1960 from the 1,048 MMcf moved to Multan in 1959.

Natural gas is increasing in importance as fuel for Pakistan's industrial growth. Plans continue for extending the Sui Gas Transmission Co. pipe line system from Multan farther northeast to Lyallpur and Lahore, and possibly eastward into India.

TABLE 2—Pakistan Oil Production in 1960

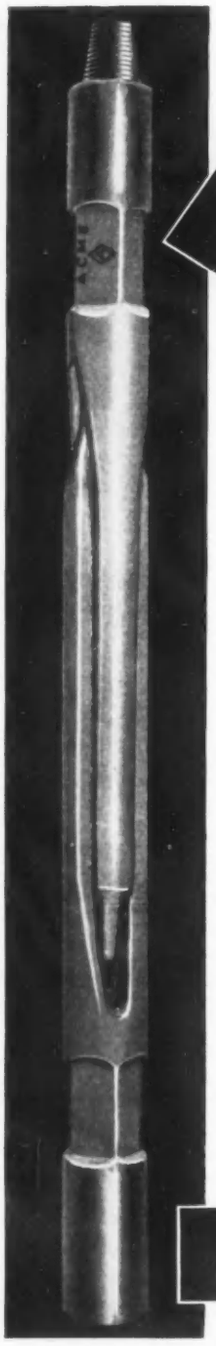
(All in Potwar Plateau Area, West Pakistan)

Company	Field	Crude Oil Production in 1960		Crude Oil Producing Wells At End of 1960			Oil Wells Shut in	Total Oil Wells
		Barrels	Bbls. Daily	Flowing	Pumping	Total		
The Attock Oil Co. Ltd.	Dhulian	1,362,789	3,732	17	...	17	12	29
	Balkassar	742,077	2,028	3	...	3	4	7
	Joya Mair	96,883	265	1	...	1	2	3
	Khaur	12,043	33	7	48	55	17	72
Total, Attock Oil Co. Ltd.		2,213,792	6,049	28	48	76	35	111
Pakistan Petroleum Ltd.	Balkassar-Karsal	425,412	1,162	3*	...	3*	...	3*
Total, Pakistan 1960		2,639,204	7,211	31	48	79	35	114
Total, Pakistan, 1959		2,093,622	5,736	25	65	90	...	...

* Estimated.

Drilling increased in 1960, with 11 wells completed, aggregating about 110,000 feet of hole, compared to 9 wells finished and 87,000 feet drilled in 1959. Five of last year's completed wells bottomed below 11,000 feet, including PPL's Lalmai 2 in East Pakistan, a dry hole at 13,506 feet. Three deep tests were being drilled at the end of December.

Other exploration. The reconnaissance phase of exploration in Pakistan is giving way to a more detailed search. Shell has stopped prospecting in the West sector in favor of East Pakistan. PPL has started work in the sand sea of Sanghar and Khisar areas of West Pakistan on which exploration licenses were granted in February 1961. Pakistan Sun Oil Co., PPL and Superior Oil Co. jointly drilled Dasori 1, a wildcat located near the southwest corner of PPL's new licenses about 120 miles



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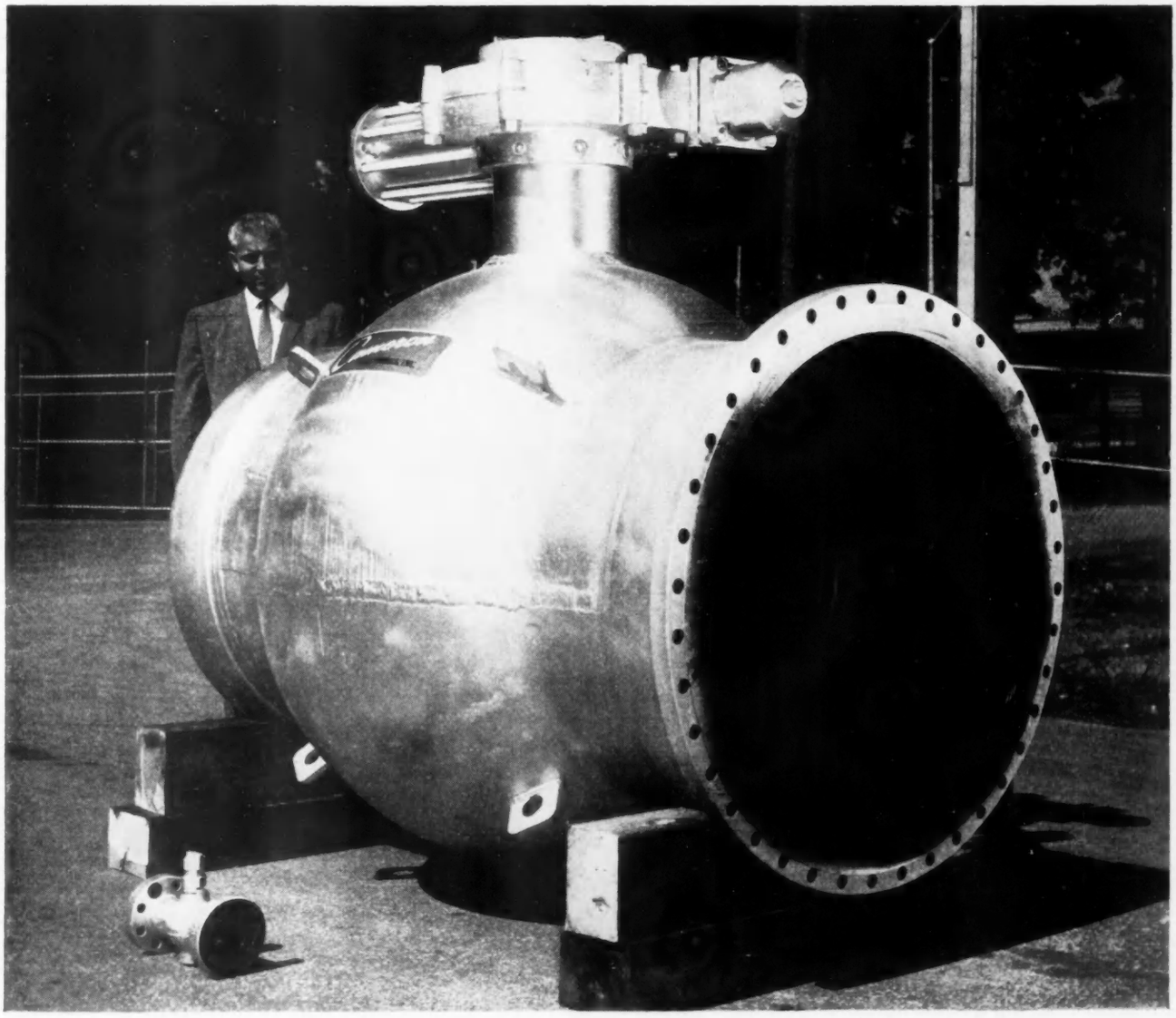

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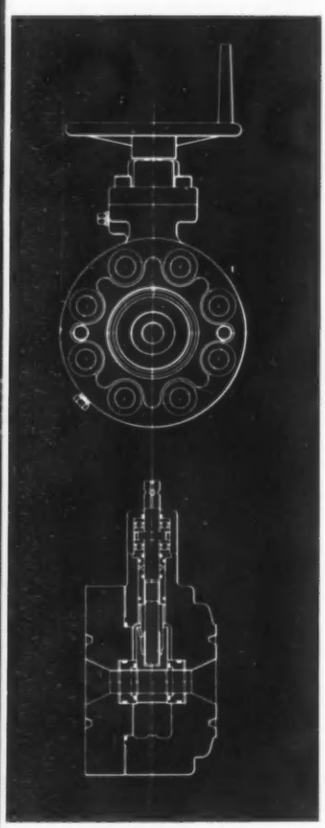

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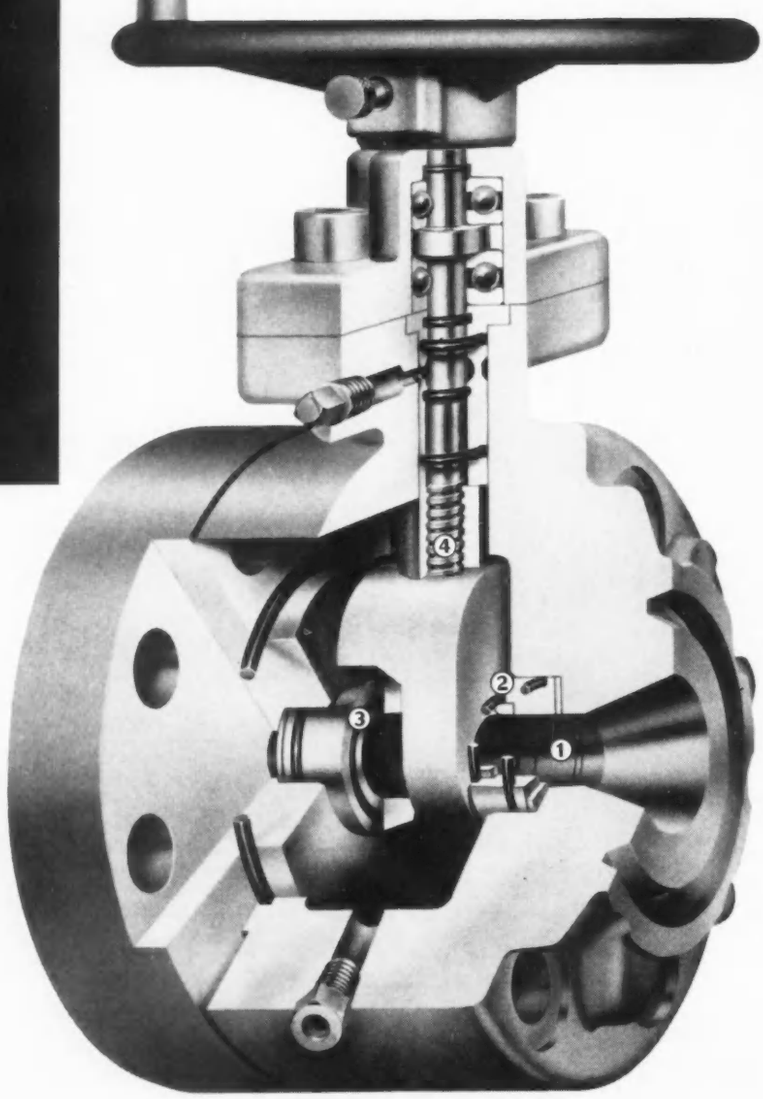

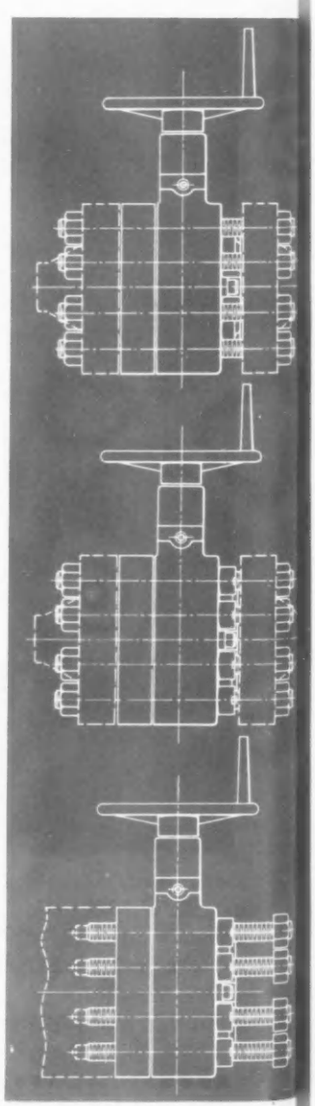

PAKISTAN

northeast of Karachi. The well spudded December 15, 1960 and was abandoned on March 30, 1961 at 11,150 feet. This year Tidewater Oil Co. expects to drill the first of several large structures it has mapped in West Pakistan.

Hunt International Petroleum Co. has suspended drilling following disappointing results in West Pakistan. Lakhra 1, located in the lower Indus Valley about 100 miles northeast of Karachi, indicated a gas discovery in 1958 at about 3,000 feet in upper Cretaceous. Further tests showed high-nitrogen, low-BTU gas. Lakhra 2, 3, and 4 wells were drilled in 1959 in an unsuccessful search for an associated oil column.

The Pakistan government, already a participant in the oil search via minority financial interests in Pak-Stanvac Petroleum Project, Pakistan Shell, etc. now plans to bring in Russian oil prospectors. An agreement between the two governments was signed March 4, 1961. Russia is to advance $30 million in credits to be repaid in rupees and/or Pakistani goods in 12 years. Oil search equipment and materials as well as technicians are to be supplied by the Soviet Union.

The split-up of Stanvac between its parent companies will work this way in Pakistan: Esso Standard Eastern, Inc. will receive all of Stanvac's interests which include 75 percent ownership of the exploration venture (Pak-Stanvac) and a share in the new refinery project near Karachi. Mobil Petroleum Co. Inc. may acquire half interest in Stanvac's exploratory activities.

Refining. Attock Oil Co.'s Morgah refinery near Rawalpindi charged an average of 6,173 bpd in 1960. The plant is rated at 8,000 bpd capacity. Increased use is being made at the refinery of natural gas produced in the oil fields.

The new $35 million, 32,000-bpd refinery at Korangi, near Karachi, is being built. It is to be completed in 1963 and operated by Pakistan Refinery, Ltd. Burmah Oil Co., Caltex, Royal Dutch Shell, Stanvac and Pakistani investors have interests in the new plant.

Plans for a petrochemical complex based on Sui gas are also underway.

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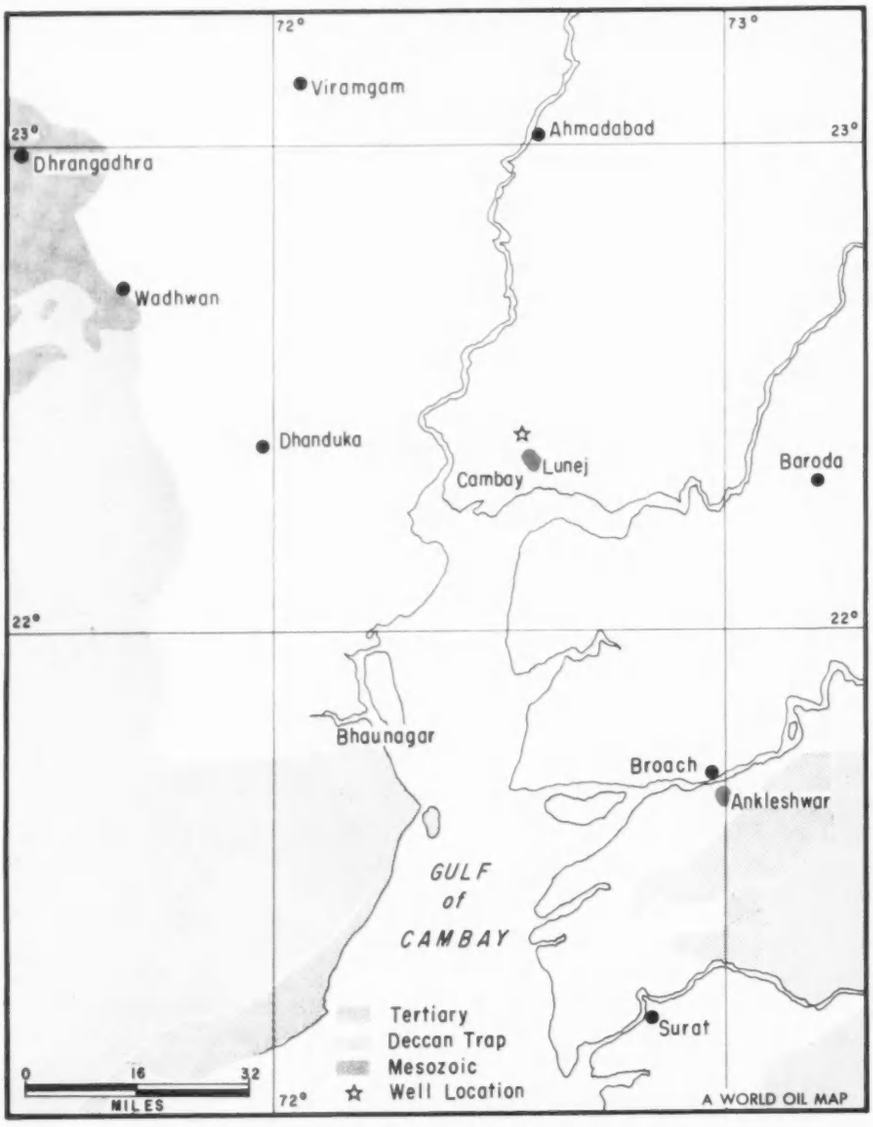
OIL FIELDS OF WESTERN INDIA



Important oil fields have been found within the past several years at Ankleshwar and Lunej (Cambay). Recently a new oil discovery has been reported about 15 miles north of Ahmadabad.

India . . . outlets being provided for new oil fields found in upper Assam and western India

By MID-1961 India was preparing to receive some tangible benefits from exploration efforts which have, during the past decade, netted important new oil reserves in upper Assam and more recently in the new Cambay-Kutch oil province of western India. New oil discoveries were made last year in both regions. By mid-1961 pipe line and refinery construction was underway to allow exploitation of unconnected Assam oil reserves, and tentative plans were being made for a new refinery to process Cambay-Kutch crude.

Drilling and Crude Oil Production in India in 1960 and 1959

ITEM	1960	1959
Wells Completed	42	21
Oil	28	14
Gas	1	2
Dry	13	5
Footage Drilled in Completed Wells	341,000	206,325
Average Depth	8,119	9,825
Wells Drilling at End of Year	10	5
Crude Oil Production, Barrels	3,284,850	3,547,800
Barrels Daily	8,975	9,720
Producing Oil Wells at End of Year	500*	550
Flowing	28*	30
Pumping	472*	520

* Estimated.

Salient 1960 statistics generally show gains: crude oil production was put at 8,975 bpd for a total of 3,284,850 barrels, less than the 9,720 barrels daily rate of 1959 but higher than the 8,600 bpd rate of 1958; and there were 42 well completions aggregating 341,000 feet of hole in 1960, an abrupt increase from the 21 completions and 206,325 feet of hole drilled in 1959.

Assam Oil Co. Ltd., wholly owned by The Burmah Oil Co. Ltd. continued to produce its 71-year-old Digboi oil field in extreme northeastern Assam, but at a reduced rate last year. The firm reported less than 4,000 bpd production in 1960, and total crude yield was estimated at 1,454,850 barrels (3,975 daily). However, the Digboi refinery processed more than 440,000 tons of crude (about 8,975 bpd), of which about 5,000 bpd or 1,830,000 barrels was produced from Nahorkatiya field. This is lesss than one-tenth of Nahorkatiya's daily production capability.

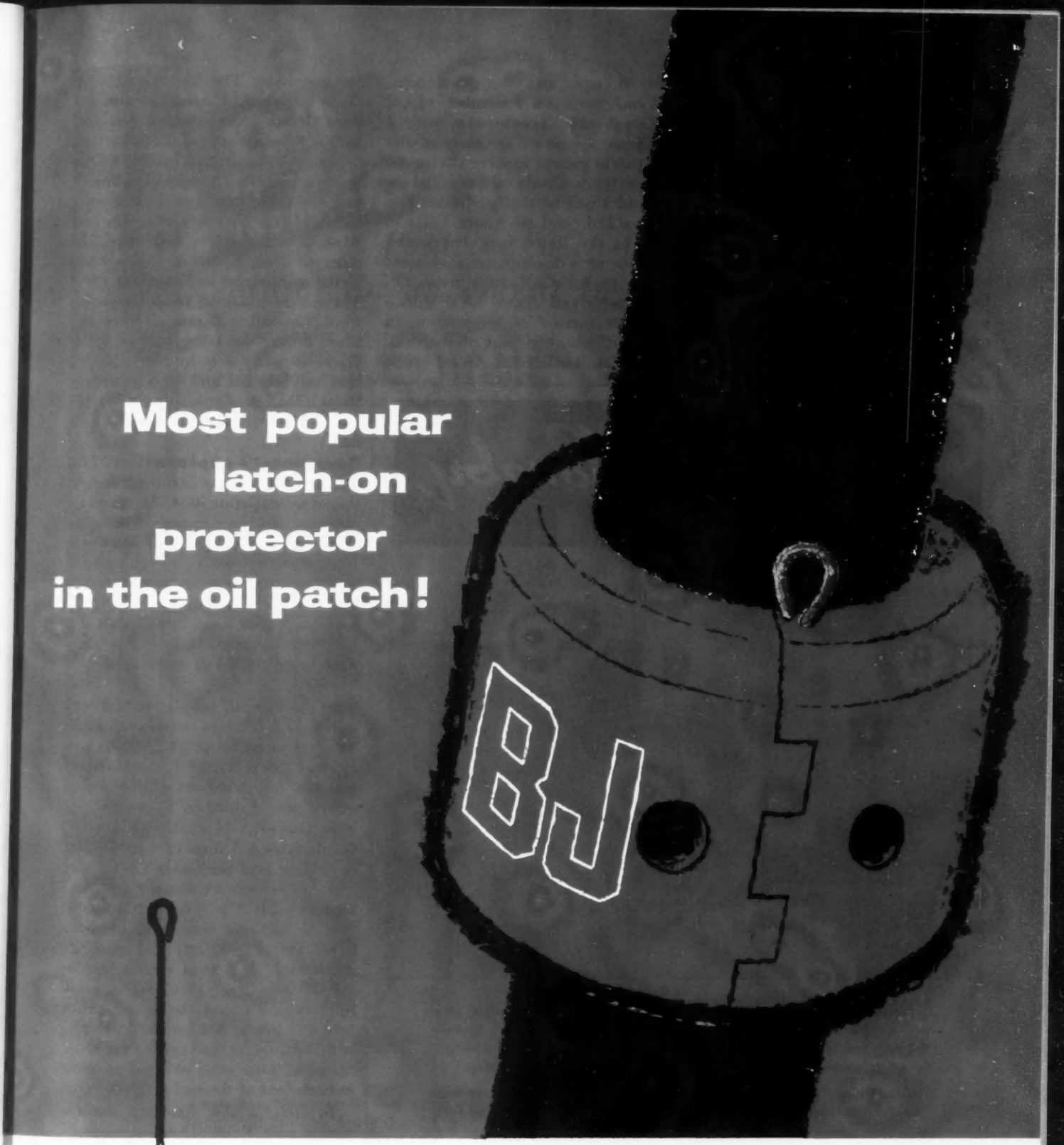
Assam Oil drilled no wells in 1960 but has a gas injection scheme underway at Digboi field for secondary recovery.

Oil India Ltd. drilled 25 deep wells in its Nahorkatiya, Hugrijan and Moran concession areas in upper Assam southwest of Digboi. Nineteen of these wells were completed as producers, 3 were dry, and 3 were in a doubtful status at the end of December. The company had four rigs in the area at the end of 1960.

On July 8, 1960, Oil India advised that recoverable reserves in Nahorkatiya and Moran fields had been estimated at 29 million tons (about 200 million barrels). Additional reserves indicated but not confirmed as of then had been appraised at about 13 million tons (almost 100 million barrels). Assuming reasonably successful continued development drilling, the company expected to be able to produce 3 million tons annually (60,000 bpd) for 15 years. The estimates were made by the consulting firm DeGolyer and MacNaughton of Dallas, Texas.

At the end of 1960, proved and indicated Nahorkatiya-Moran crude reserves were put at 284.1 million barrels. Gas reserves were estimated at 719,034 MMcf.

On May 19, 1961, Oil India had drilled its hundredth well, Nahorkatiya 86. The other 14 are at Moran.



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These wells represent 1,037,132 feet of hole for an average depth of 10,371 feet. Of the 86 wells at Nahorkatiya there were 61 oil wells, 7 gas wells, 12 wells awaiting further testing, and only 6 dry holes. At Moran there were 8 oil wells, 1 gas well and 5 dry holes.

On May 31, 1961, an agreement between the Indian government and Burmah Oil Co. Ltd. was signed. Burmah will sell one-sixth of its share in Oil India Ltd. to the government, raising the latter's interest to 50 percent. Burmah and the government will each nominate 4 members to Oil India's 8-man directorate, with a chairman appointed by each of the two parent groups to serve during alternate years. Crude oil produced by Oil India will be sold to Indian Refineries Ltd. and to Assam Oil Co. Sales to the former will be figured in terms of a discount on equivalent quality Persian Gulf crude prices. Oil India received about 1,800 square miles for further oil exploration in northeast Assam as part of the deal.

Pipe line outlets for Assam crude are underway. The Burmah Oil Co. (Pipe Lines), Ltd., working with the West German Mannesmann firm and Italy's Saipem as main contractors, began construction late in 1960 of the first stage of the 720-mile pipe line to supply crude to government refineries to be built at Nunmati in Assam and Barauni in Bihar. The first stage, 270 miles of 16-inch line is to be completed to Nunmati in November 1961. The second 450-mile, 14-inch segment from Nunmati to Barauni is to be finished during the latter half of 1962. Initial capacity is to be about 55,000 bpd to Nunmati and 40,000 bpd to Barauni, with capacity to be expanded ultimately to 80,000 barrels daily.

Government's exploration. The Oil and Natural Gas Commission continued to accelerate its wildcatting operations, and development drilling in Cambay-Kutch, during 1960 and 1961. Fourteen wells were completed last year, aggregating about 90,000 feet of hole. Ten deep drilling rigs, 5 Russian, 3 Rumanian and 2 from the U.S. were operated in 1960. Six wells were being drilled at the end of December.

In the Punjab, Jawalamukhi 2 was drilled to 3,723 feet last year to evaluate gas shows found at 2,900 feet in 1959 at Jawalamukhi 1. At Hoshiarpur, one test had been drilled and a second was drilling in December.

In Gujerat (Cambay-Kutch), Cambay wells 3 thru 12 were drilled or drilling as of the end of December; also Ankleshwar 15 thru 20 and Ankleshwar 23. The Lunej (Cambay) field wells were bottoming between 6,000 and 7,300 feet, and most at Ankleshwar had total depths in the 4,700-5,000 foot range. Eight wells were completed on the Lunej structure and five at Ankleshwar last year, with oil and/or gas present in most of them. Two wells were in progress in each field at the end of 1960.

In 1961, a new discovery was reported near Kalol, 15 miles north of Ahmedabad. The new find was thought to be perhaps comparable to Ankleshwar. Oil was found at about 5,000 feet.

The Oil and Natural Gas Commission is expected to test the productive capacities of Cambay and Ankleshwar fields late this year. Recent reports indicate that the original tentative appraisals at Ankleshwar may have been too optimistic. However, a

the heart of every camp

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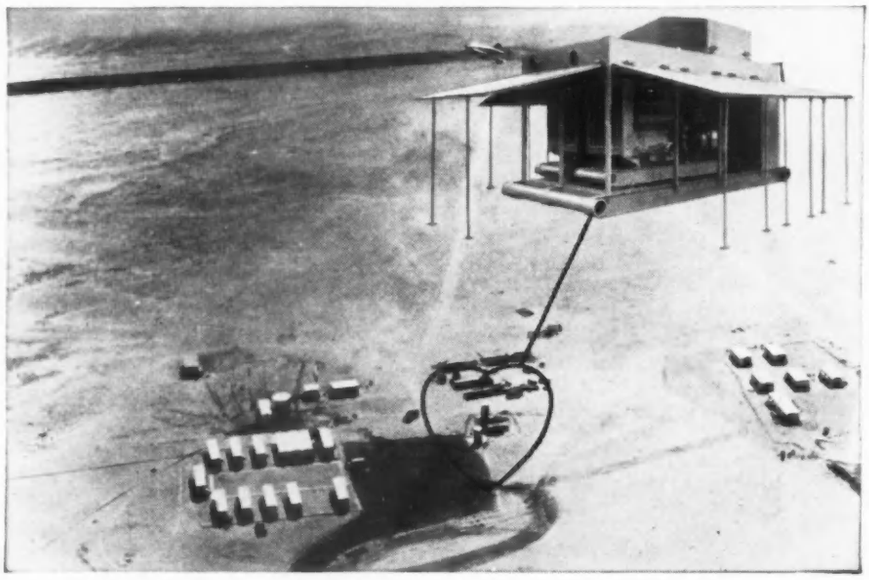

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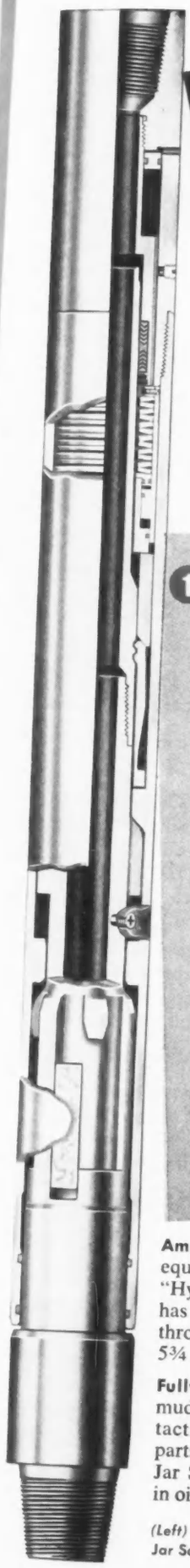

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Again Shaffer brings a major new oil tool advancement to the oil industry, a "3-In-1" Fishing Jar that combines, in one tool, the protection of a "Hydraulic Trip" Straight-Pull Jar . . . plus the protection of a *Mechanical* Trip "Standby" . . . plus the controlled releasing action of a positive Safety Joint in the event the fish cannot be loosened and it is desired to release the fishing string.

Never before has a single tool combining such a wide range of safety features been available to the oil industry!

1 USED AS A HYDRAULIC JAR

Normally used as a straight-pull "Hydraulic Trip" Jar, this new Shaffer tool permits the force of each blow to be easily controlled at the surface. The operator simply takes a pull on the fishing string. This pull, acting through a built-in hydraulic chamber, causes the desired blow to be struck as soon as sufficient fluid passes through an orifice in the tool—a matter of only a few seconds between the time the pull is taken and the blow is struck.

- The tool re-sets itself automatically when the string is lowered, and repeated blows can be struck by simply raising and lowering the string!
- No torque is required—either to strike the blow or to re-set the tool!
- The force of the blow can be easily controlled by noting the amount of pull registered on the weight indicator. To strike a heavier blow, merely increase pull. To reduce blow, take less pull. *It's that simple!*
- Once the desired pull has been determined, the entire operating sequence can be timed by the driller so there is no loss of time while tripping or re-setting the tool!

2 MECHANICAL TRIP STANDBY

If for any reason the "Hydraulic Trip" should fail to function, a simple manipulation of the run-in string by-passes the hydraulic system so that the tool can be operated *mechanically*. This is a marked improvement over other hydraulic Jars which become inoperative should the hydraulic system fail!

3 POSITIVE SAFETY JOINT RELEASE

Still another unique feature is the built-in Safety Joint in the lower portion of the tool. If the fish cannot be loosened, and it is desired to release the run-in string, simply trip the tool and apply left-hand torque as the string is slowly lowered. This rotates locking lugs into releasing slots so that the string and a major portion of the tool itself can be recovered. The recovered portion of the Shaffer "Hydraulic Trip" Jar Safety Joint can then be used at the bottom of any subsequent fishing string to simplify reconnection with the fish!

Ample Bore Diameter: So that wire line equipment can pass freely through the "Hydraulic Trip" Jar Safety Joint, it has been designed with a generous bore throughout its length. For example, the 5¾ O.D. tool has a full 2″ bore!

Fully Oil-Sealed: To prevent abrasive mud, sand or corrosive well fluids contacting the mechanism, all operating parts of the Shaffer "Hydraulic Trip" Jar Safety Joint are completely sealed in oil!

(Left) The Shaffer "Hydraulic Trip" Jar Safety Joint in "Set" Position

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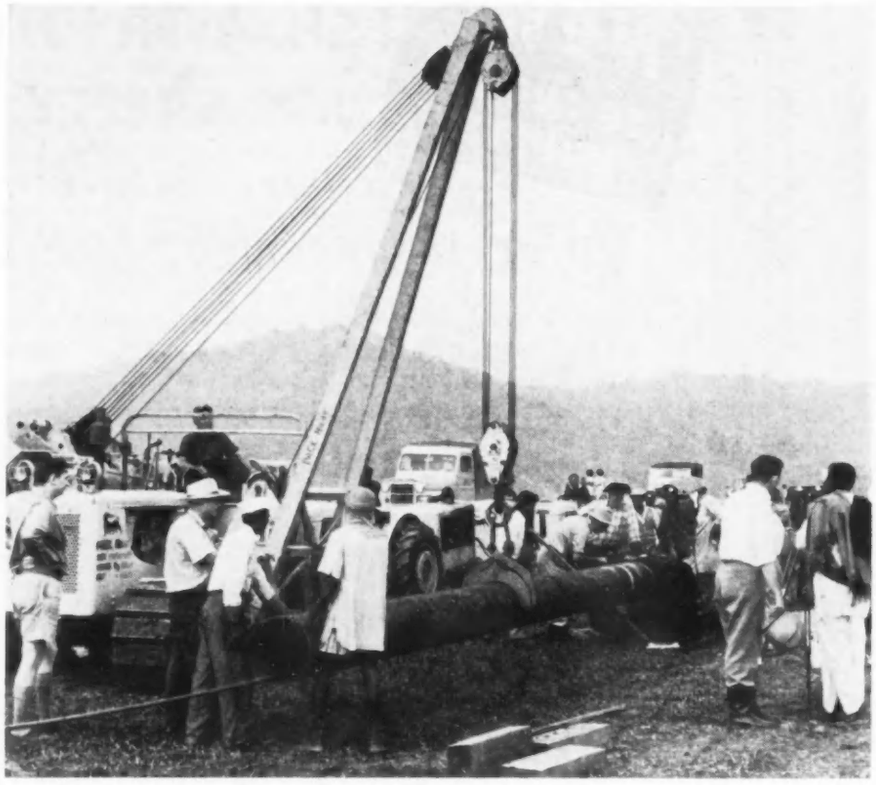

Work progresses near Nunmati, Gauhati, Assam, on 720-mile long pipe line.

refinery to process Cambay-Kutch crude was being seriously considered. Capacity mentioned was 2 million tons annually (40,000 bpd), indicating confidence that sizable reserves are being developed.

In Assam, Rudrasagar 1, the first test on a big structure was drilled last year, near Moran and Nahorkatiya. The well spudded on May 29 and bottomed on September 21 at 12,523 feet. Casing was cemented on bottom, and three separate intervals close to bottom tested salt water. A fourth deep zone tested oil and a discovery was announced. Two prospective zones still farther uphole remained to be tested this year.

In other exploration by the Commission, crews worked as follows:

Type	No. of parties, 1-1-'60	No. of parties, 12-31-'60	Party months worked in '60
Geological	20	18	135
Geophysical	17	22	107
a. Seismic	9	12	61
b. Gravity	8	10	46

Coverage included parts of the Himalayan foothills of Punjab and

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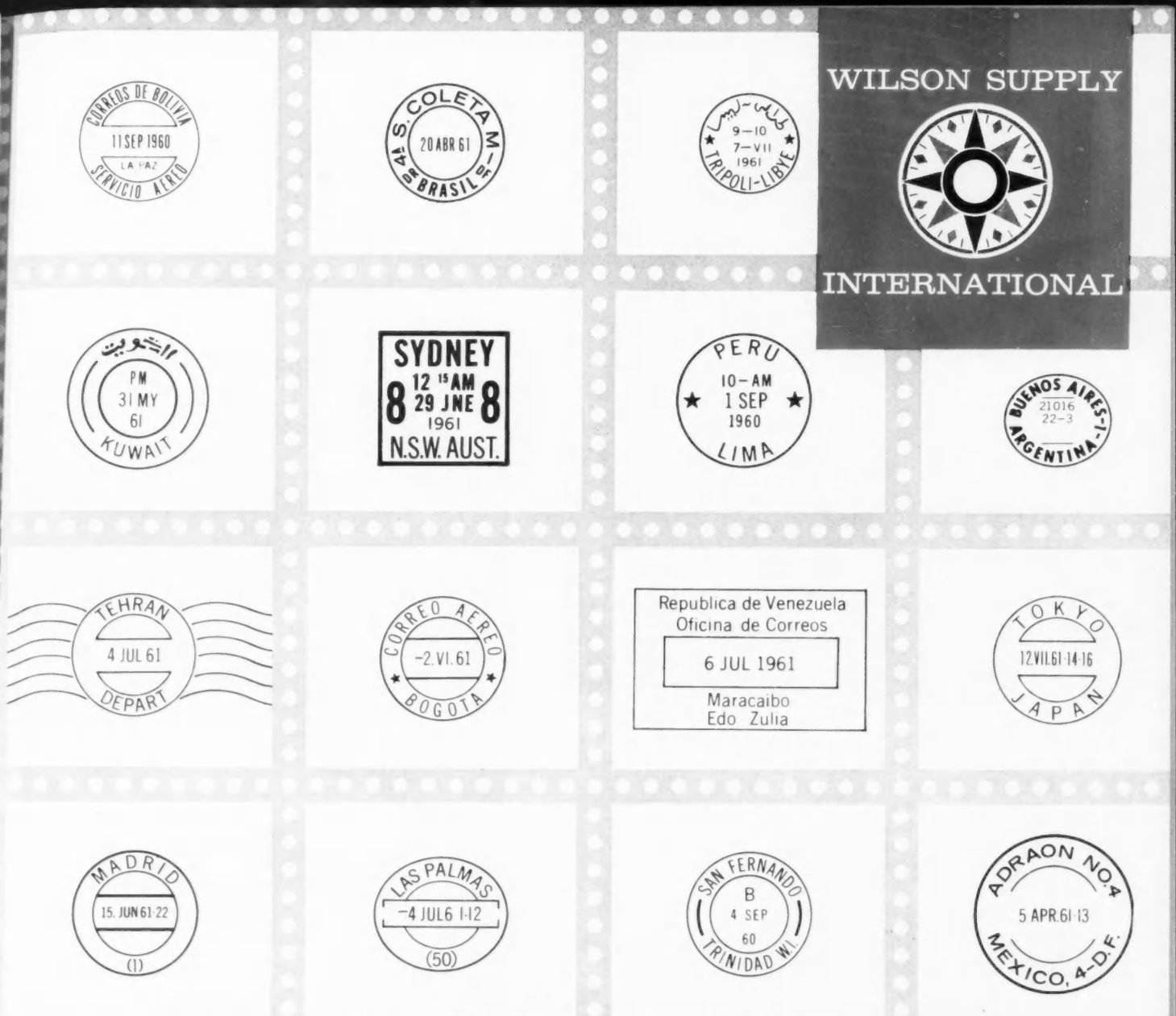

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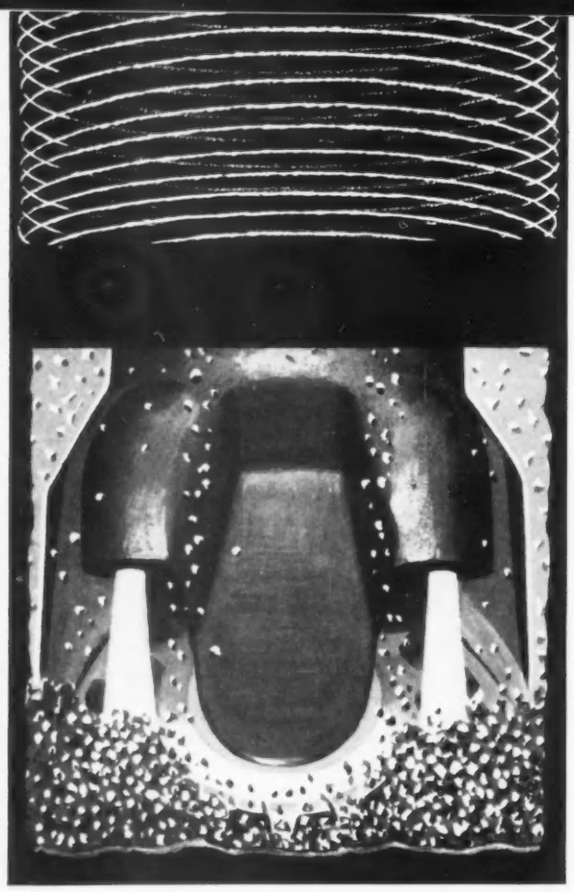
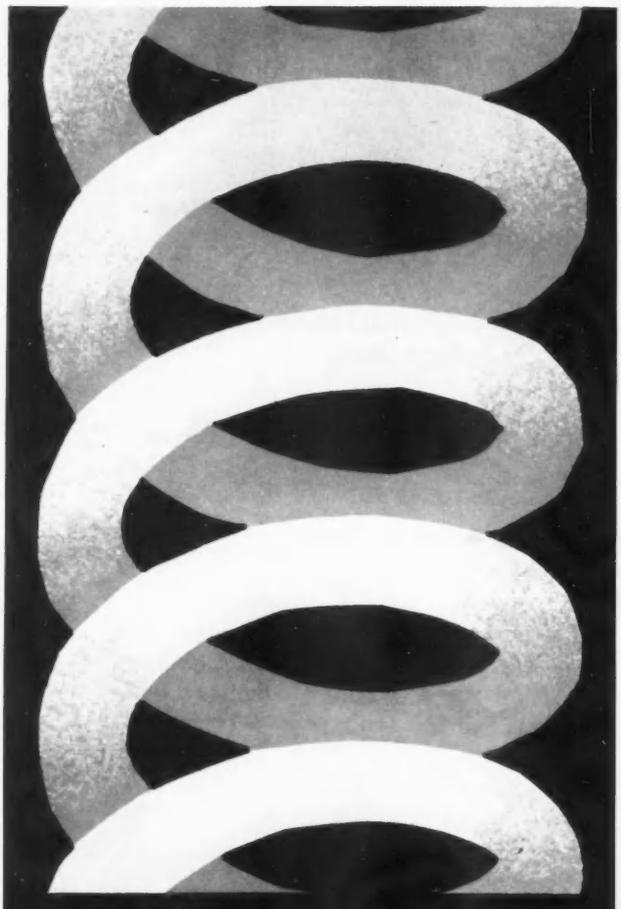
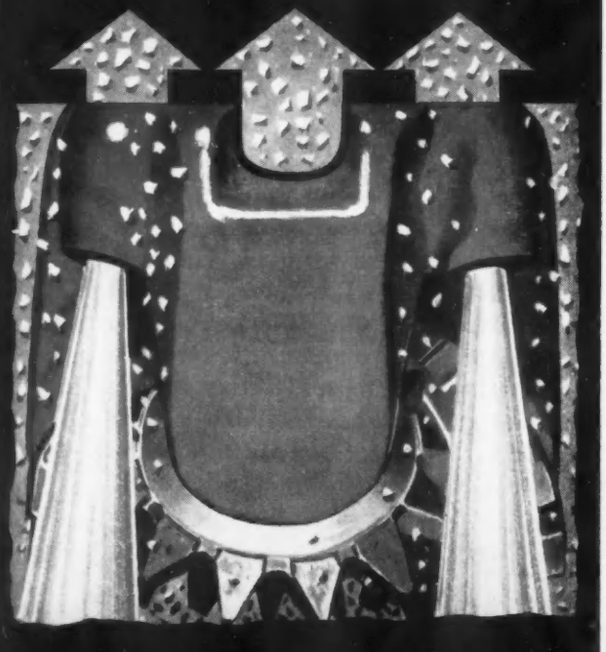


milling or drilling?





How can you tell if you're milling or drilling? It's easy. If you are using Reed Flush-Flo jet bits you **know** you're drilling ahead. Here's why—

1—The Flush-Flo ports allow an alternate route around the high velocity jets. Laboratory tests prove the Flush-Flo design allows the drilling fluid to sweep the entire bottom of the hole, whereas other jet type bits develop little fluid movement at the center.

2—Jet bits without Flush-Flo ports require all cuttings and circulating fluid to return past the high velocity discharge jets. Flush-Flo design provides up to 50% more return area, prevents re-circulating of cuttings, balling and re-drilling cuttings.

3—The Flush-Flo ports minimize hydrostatic pressure on the formation when running in the hole and minimize swabbing when pulling the string. These two factors afford maximum protection and minimum mud bills when drilling in lost circulation areas and leave wall cake and walls in better condition.

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INDIA

Uttar Pradesh (U P); Ganga Valley of U P and Bihar, Nepal, Rajasthan, and the plains of Gujerat and Saurashtra, Kutch, West Bengal, Assam and parts of the east and west coasts. A few interesting structures were reported in the Ganga Valley, and a stratigraphic rig has been sent there. Detailed reflection and refraction seismic surveys in the Cambay, Ankleshwar, and Kosamba areas indicated some fairly prominent structures. Some surprising oil and gas indications have recently been reported in Nepal.

Standard-Vacuum Oil Company. Stanvac completed its Port Canning 1 deep test below 13,000 feet early last year, and drilled two additional dry holes, West Ranaghat 1 and Ghatal 1, thus completing its unsuccessful oil search in West Bengal. The 10 holes completed by Stanvac since acquiring the 10,000-square-mile Indian concession late in 1954 amount to 98,000 feet of drilling. Stanvac is seeking new acreage (in northwest India) if suitable terms can be acquired.

The Stanvac split-up will work this way in India: Esso Standard Eastern, Inc. will receive all Stanvac interests, including the 37,700 bpd refinery near Bombay. But Mobil Petroleum Mobil Petroleum Co., Inc. has the right to receive a half interest in any Stanvac exploratory ventures in India.

New concessions? India is interested in acquiring more outside capital to shoulder more of the oil exploration burden. Some oil firms in the U.S., Japan, Italy, etc., have expressed interest. Negotiations early in 1961 were being complicated by the Indian government's insistence on 50 percent ownership of new companies to be formed for exploration, on receiving more than 50 percent of profits, and on creation of a monopolistic future position for itself regarding refining and marketing.

Demand. Product demand in India amounted to about 110,000 bpd, largely for kerosine and fuel oil. This figure is expected to double within the next six years. Total energy demand is expected to increase ten-fold from 69 million tons of coal equivalent in 1961 to 696 million tons coal equivalent in 1986.

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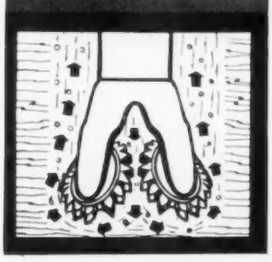

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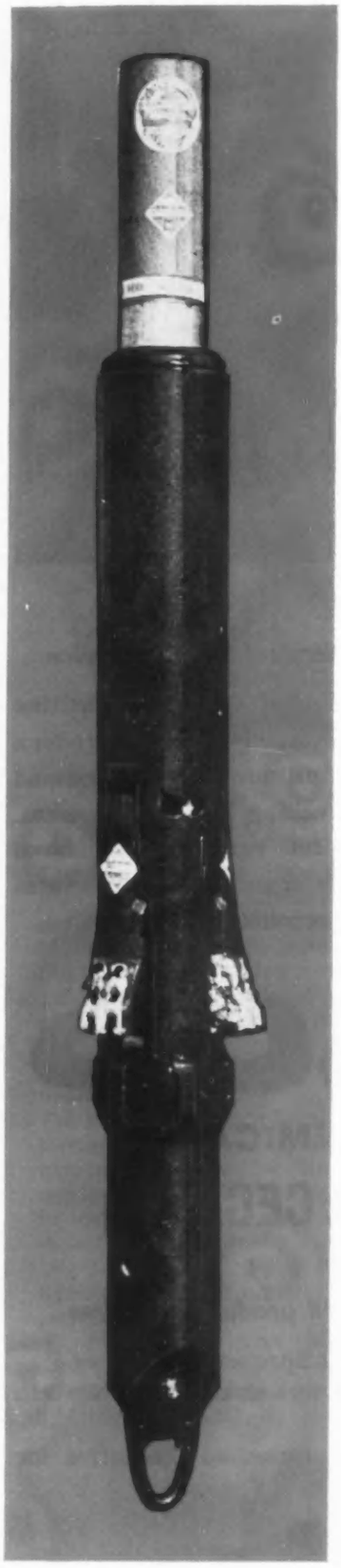

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Jet washing removes the loose or soft formations, fractured cement and the mud ring. Immediately laying in the cement plug eliminates the re-build up of the mud ring—thus a perfect plug is assured.

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Each slip acts independently of the other in Burns Casing Hangers, so that the load is evenly distributed by the entire area of all the slips. Positive action is assured by the provision of three springs to raise each slip. Slips are free to release as the load is removed and will act as a reliable casing catcher when retrieving the liner. Circulating grooves can be milled in the body between the slips for cementing. Circulating grooves reduce the velocity around the hanger assuring a better cement job. Cementing the well can be done either before or after the hanger is released.

Burns Casing Hangers can be set properly even though the oil string is frozen by rotating the running in string six turns to the right which allows the slips to raise against the water string and by taking a stretch on the frozen oil string. Hanger is set and casing suspended properly. Burns casing hangers do not depend on drag spring friction action to set the slips.

BURNS PLAIN TYPE CASING HANGER

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BURNS LEAD SEAL CASING HANGER

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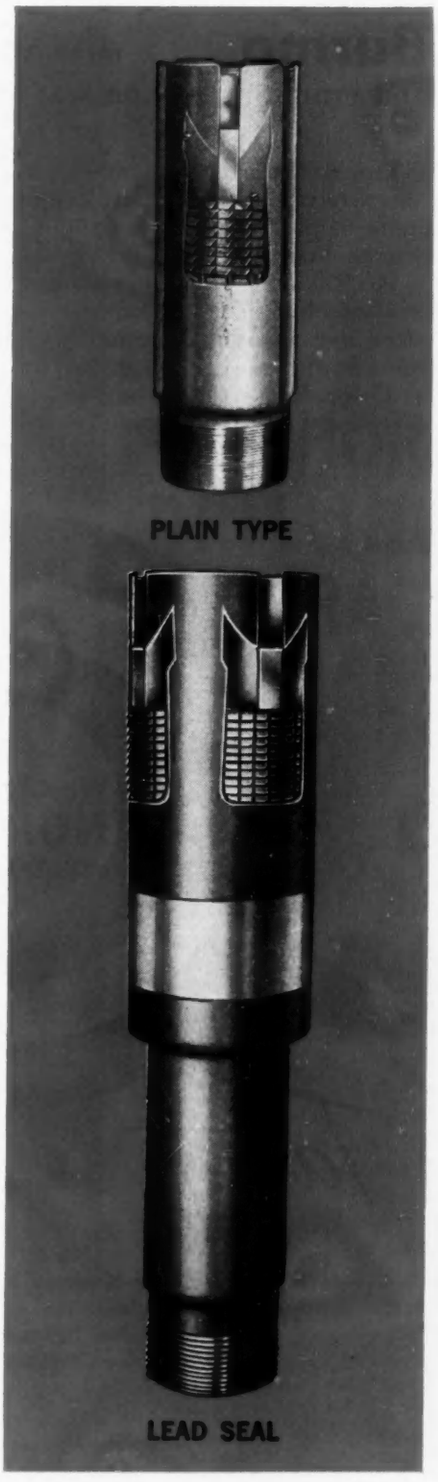

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Burma . . . more wells and footage were drilled and crude production was increased in 1960

THE BURMESE OIL INDUSTRY continued to make steady progress, with crude output edging upward by 4.2 percent last year to 11,107 bpd (4,065,000 barrels total) compared to 10,664 bpd in 1959. Domestic demand rose accordingly, requiring expansion of refining facilities for locally-produced crude. The Burmese government placed itself more strongly in the oil business, but also granted an exploration license to a newcomer early this year.

Production. Last year's crude oil yield included almost 9,750 bpd (see Table) from Chauk/Lanywa and Yenangyaung districts of central Burma by The Burma Oil Company (1954) Ltd., a joint venture firm; and an estimated 1,366 bpd by local independent operators. BOC (1954) Ltd. had 410 wells on production at the end of December, compared to 394 as of a year earlier.

In April 1961 BOC's production averaged 8,340 bpd, including 7,570 from Chauk, 500 at Lanywa, and 270 bpd from the company's holdings in Yenangyaung field.

Drilling. BOC completed 38 development wells aggregating 118,507 feet of hole last year, compared to 29 field wells and 87,703 feet of development drilling in 1959. Exploratory drilling amounted to 37,242 feet in 1960 compared to 34,500 feet in 1959.

Active drilling continued in early 1961. One well was completed during April at Chauk and another spudded on April 11. Also, Lanywa 124 reached total depth of 3,700 feet on April 19 and 5½-inch casing was set preparatory to testing the main producing sand. At Yenangyaung field, well 3028 was being treated in March, and Yenangyaung 3029 was spudded on March 25. The latter well bottomed at 5,289 feet; oil output was 240 barrels during the first day of production testing.

Wildcat drilling in Burma failed to find new oil reserves last year, but sizable gas reserves with some condensate were indicated. BOC's third test drilled in the Irrawaddy delta, Payagon 1, located eight miles west of Kyaiklat, bottomed at 13,108 feet in 1959 and was tested in 1960. Contrary to earlier hopes, only a small gas sand was indicated. A second well to determine the extent of the gas sand was underway last December.

North of Rangoon another wildcat was drilled at Tharrawaddy. By April 1961 a depth of 11,006 feet had been reached in deviated hole sidetracked at 6,514 feet. Drill pipe was stuck 380 feet off bottom while tripping in. The rig was thence moved to Kyun Nyogyi farther south in the Irrawaddy delta where drilling was expected to be underway by June.

Farther upstream in the Irrawaddy Valley, a test at Yedwet, east of Yenangyaung was spudded on January 18, 1961. Yedwet 4 reached 10,200 feet, and testing of some shal-

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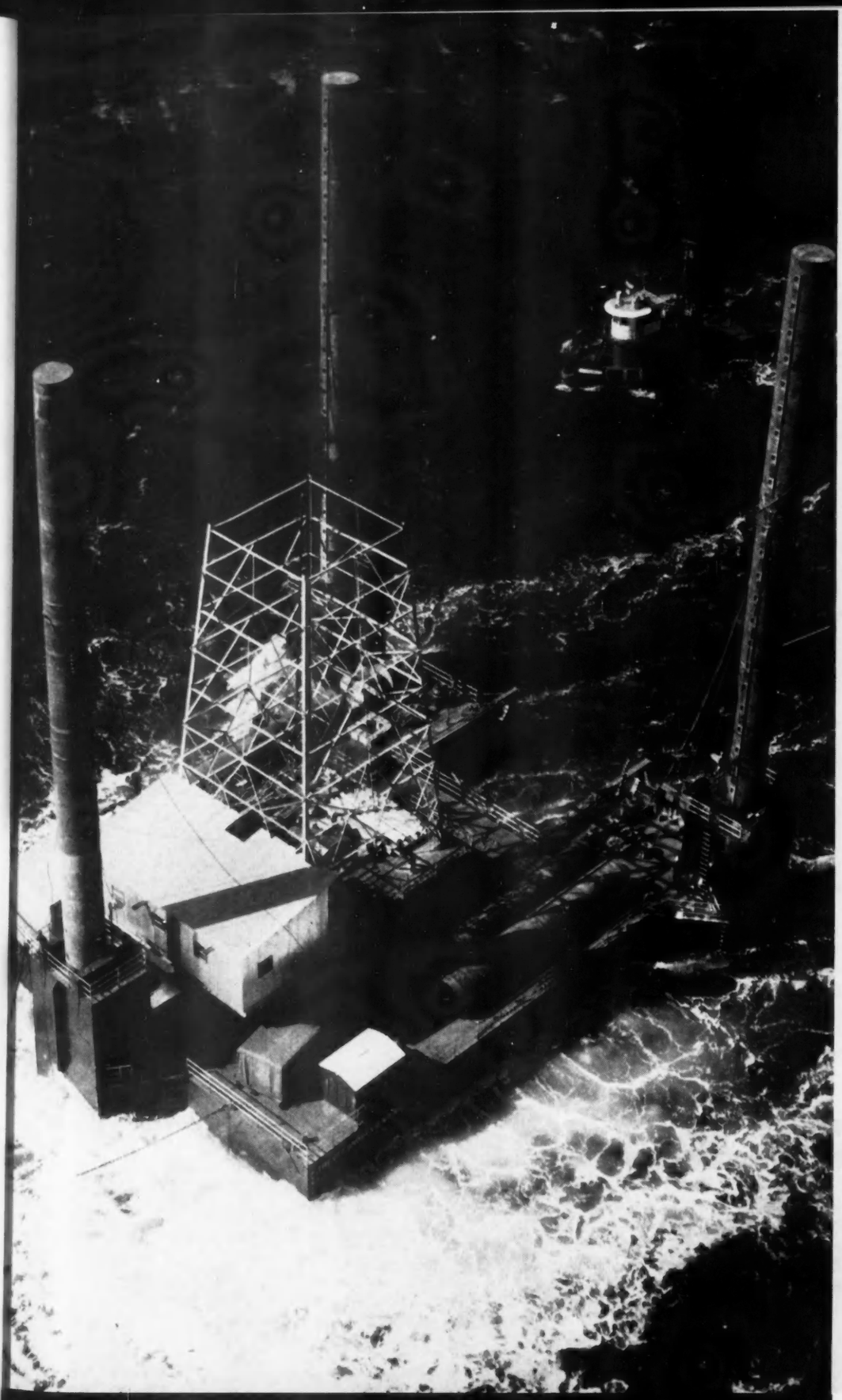

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low sands, described later as disappointing, was underway in April. The rig was being dismantled in May to be moved to Yenangyaung to drill an 11,000-foot test (Well 3031) to probe below known pay zones.

Another wildcat location, Aunglanmyo, near the Irrawaddy's east shore south of Yenangyaung and north of Prome, was also scheduled for drilling this year.

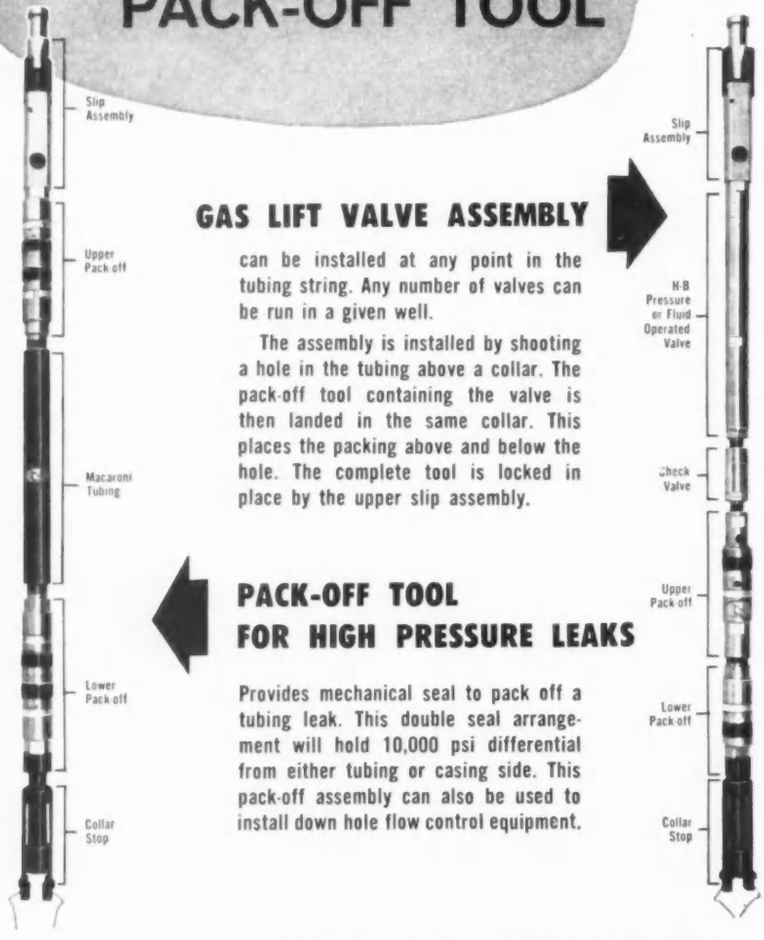
Crude Oil Production, Producing Wells, and Drilling in Burma in 1960

COMPANY	CRUDE OIL PRODUCTION IN 1960		Crude Producing Wells, at End of 1960	FIELD WELLS DRILLED IN 1960				Development footage drilled in 1960
	Total Barrels	Barrels Daily		Oil	Gas	Dry	Total	
Burma Oil Co. (1954) Ltd.	3,565,000	9,741	410	30*	0*	8*	38	118,507
Independent Producers, Yenangyaung and other fields	500,000*	1,366	†	†	†	†	†	†
Total, 1960	4,065,000	11,107	410	30	...	8	38	118,507
Total, 1959	3,892,200	10,664	394	20	1	8	29	87,900

* Estimated. † Not available.

H B

TYPE "R" RETRIEVABLE PACK-OFF TOOL



GAS LIFT VALVE ASSEMBLY

can be installed at any point in the tubing string. Any number of valves can be run in a given well.

The assembly is installed by shooting a hole in the tubing above a collar. The pack-off tool containing the valve is then landed in the same collar. This places the packing above and below the hole. The complete tool is locked in place by the upper slip assembly.

PACK-OFF TOOL FOR HIGH PRESSURE LEAKS

Provides mechanical seal to pack off a tubing leak. This double seal arrangement will hold 10,000 psi differential from either tubing or casing side. This pack-off assembly can also be used to install down hole flow control equipment.

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BURMA, E. PAKISTAN, AND ASSAM

Wildcatting was being accelerated in Burma in 1960 and 1961, and crude oil output increased to meet rising domestic needs. Utilization of natural gas in East Pakistan was underway, and pipe line outlets for unconnected oil fields in India's Assam province were being built to tie in with new projected refineries.

Other exploration. Some seismic and gravity work was done in the Irrawaddy delta, and some geophysical work was also reported farther upstream in the Minhla area. BOC has budgeted almost $5.6 million annually during 1961, 1962 and 1963 for the search for new oil reserves in Burma.

Early in 1961, General Exploration Co. of California was granted a license to conduct geophysical surveys in a 10,000-square-mile area in the Irrawaddy Valley in central Burma.

Government participation. In September 1960 the government exer-

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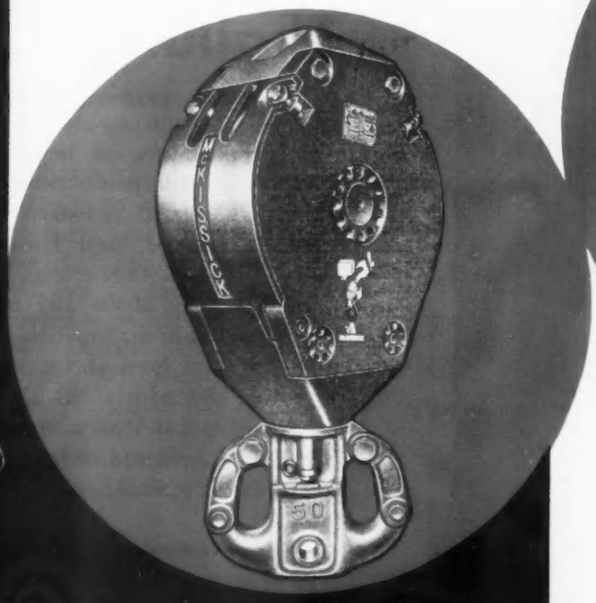

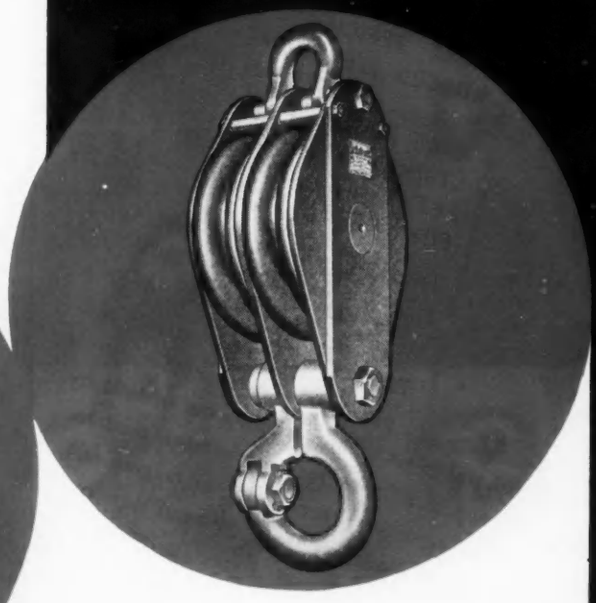

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These are among the many features that make the T-I-W Type HDSL SNAP-LOK Dual String Packer first choice for dual completion efficiency: Packer can be set, released and re-set without coming out of hole by use of snap lock. Snap lock mechanisms used for positive indication when setting or tagging seal nipples. Positive acting, dove-tail slips are easily set and unset. Especially designed packoff rubbers, seat and seal easily, with minimum of weight. Setting weight on second string does not add weight to bottom packer through first string.

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BURMA

cised its option under the 1954 agreement to acquire a further 17⅓ percent interest in The Burma Oil Co. (1954) Ltd., increasing the government's shareholding interest from 33⅓ to 51 percent.

Transportation. The Burmese industry is still hampered by the lack of a pipe line system between the Chauk-Lanywa-Yenangyaung area and the Syriam refinery near Rangoon. An existing pre-World War II line was damaged beyond repair during the war. Crude oil transporation by river barge was restricted in 1960 by severe

Thailand . . .

THAILAND'S EFFORTS to develop a domestic oil industry were making slow, painful progress in 1960 and 1961. Crude oil production at Mai Fang field located in extreme northwestern Thailand, near Laos to the east and Burma to the west, was reported at only about 100 bpd last year. The small, shallow field was believed to have been about drilled up by early 1960, with about 25 producers completed at that time. Only the better ones were said to be making as much as 10 bpd. All were pumpers.

Cambodia . . .

SOME SCATTERED INFORMATION indicates that there is some current oil exploration activity underway in Cambodia. It is in the Mekong River Valley south of the Korat Plateau, which is a large Juro-Triassic escarpment partially explored in the subsurface by numerous water wells. This high topographic feature lies mainly in Thailand and Laos. A Paleozoic section in Cambodia, topped by Permian strata and believed to be intensely faulted, may be prospective. At least one major oil company would be interested in conducting further investigation there under a more favorable political climate.

Oil drilling operations were started in 1960 in the Sihanoukville area,

shoaling in the Irrawaddy. Low water is also a problem in the dry season.

Refining. Both refineries boosted thruput last year by about nine percent. An average of 5,250 barrels daily was charged at Syriam, compared to 4,810 bpd in 1959; and the Chauk plant processed 4,550 bpd in 1960 compared to 4,180 bpd the previous year. Since the Syriam refinery is running at near capacity, and domestic demand is increasing, BOC plans to more than triple capacity to about 20,000 bpd by early 1963. Contracts for the expansion were to be awarded by mid-1961.

more crude oil is needed

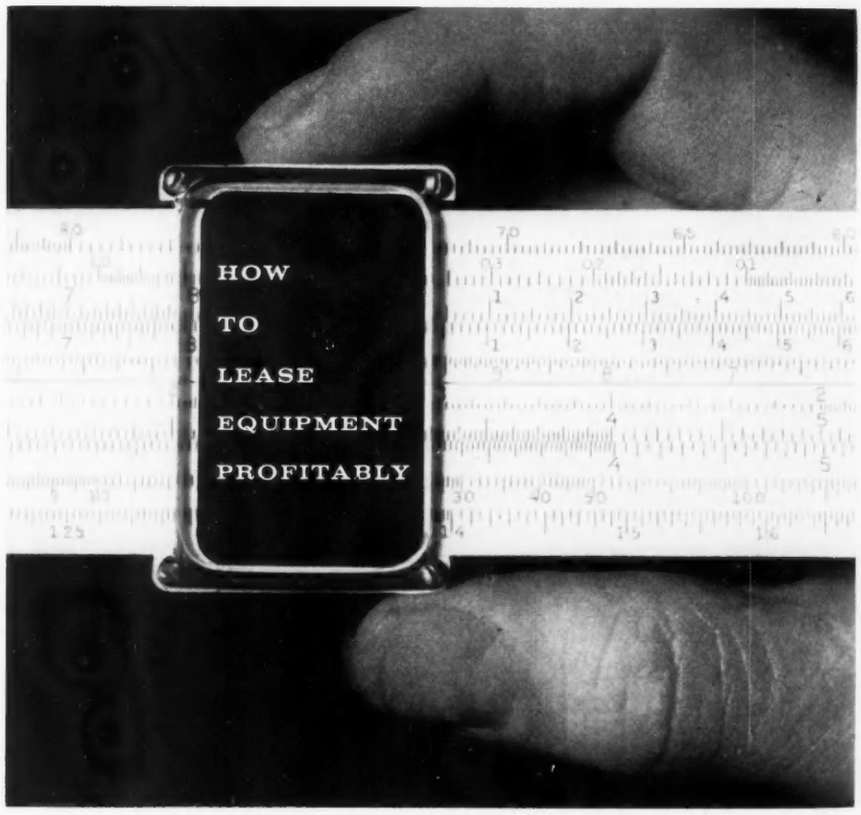
The crude yield last year was believed sufficient to run the small Mai Fang refinery for only about three days monthly. Difficulties in operating the plant, and also with product quality, particularly crucial to the Thai army now that neighboring Laos is threatened with Communist takeover, were reported to be serious.

The Thai Defense Ministry continues to attempt to stimulate interest in exploration. Thailand has mediocre oil possibilities on the Korat plateau and the Mae Nam valley, in addition to the Mai Fang vicinity.

oil exploration is indicated

according to the Cambodian Ministry of Plans, as quoted in the *Foreign Commerce Weekly*. Two wells were drilled in 1960, according to other sources, probably averaging about 5,000 feet in depth.

Cambodia has been variously reported to be the scene of oil exploration by technical groups from France, Red China, Taiwan, Poland and Russia. It is definitely receiving technical help, coordinated by the United Nations, for a proposed multi-dam system, to develop hydro-electric power and to control the Mekong River. Hence, the geology and, accordingly, oil possibilities in Cambodia are becoming better known.



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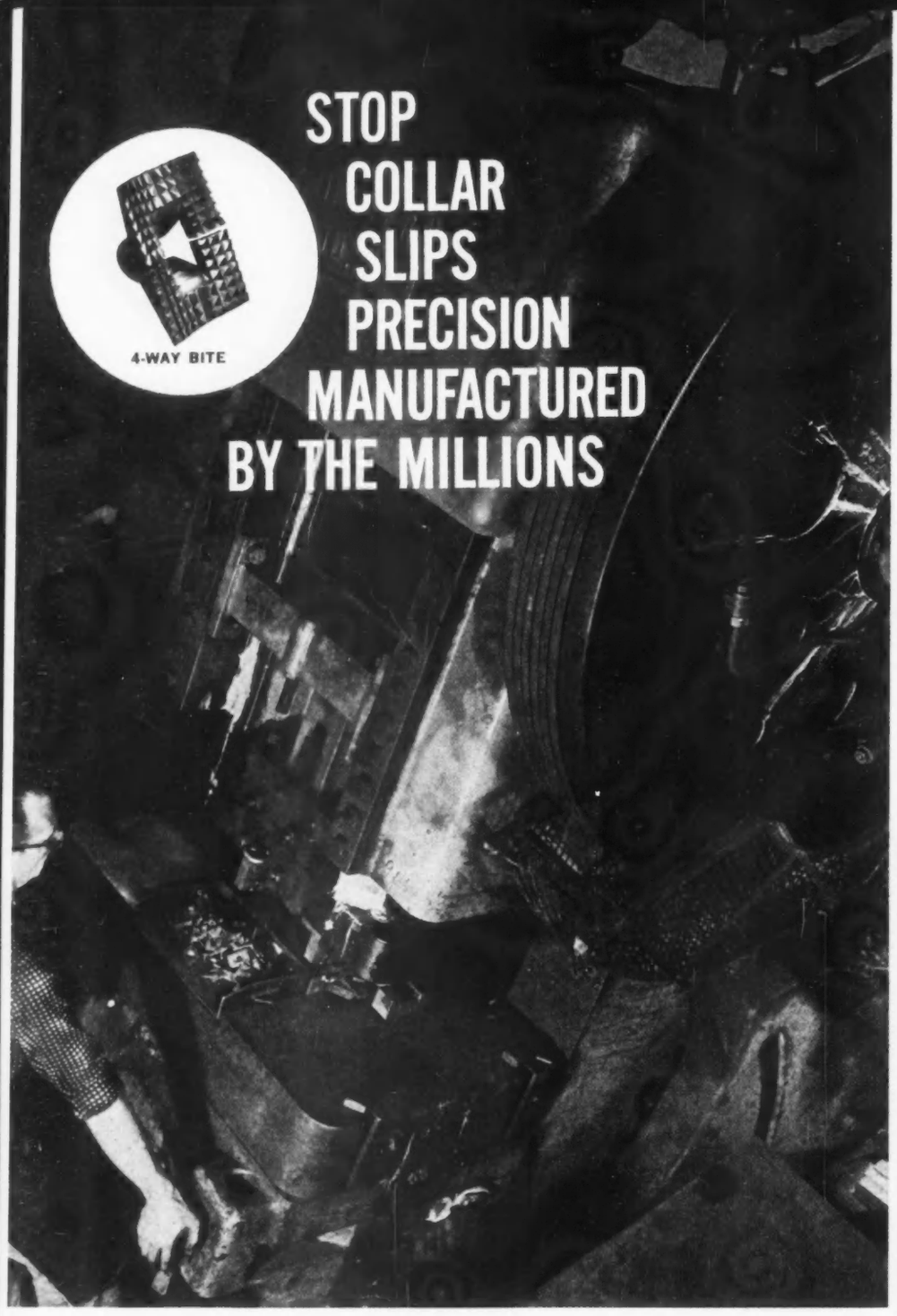

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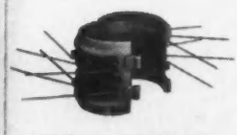

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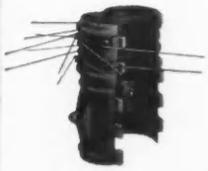

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China . . . industry breakdown is suspected

VERY LITTLE authoritative data on Red China's oil industry have been made public during the past year. There has even been a relative lack of strong claims of spectacular recent exploration successes by the Peking government. This contrasts with the 1956-1959 period, when heavy increases in crude oil production were claimed, and optimistic projections, one calling for 120,000 bpd crude oil production in 1962, were heard.

It is now estimated that crude oil production in 1960 averaged 35,000 bpd, aggregating 12,810,000 barrels. It was believed that the 60,000 bpd figure previously claimed for 1959 was inflated, either through inclusion of shale oil production or through deliberate overstatement of crude oil production figures at local levels to appear to fulfill quotas.

Hence, it is possible that the Yumen district in northwest-central China continues to provide the bulk of current production, despite reported successes in the more remote Tarim, Dzungarin, Turfan, and Tsaidam basins and in Szechwan (WORLD OIL, November 1960, pp. 138-158). Transportation, communication, refining, and distribution problems are being compounded by shortages of equipment and qualified technical personnel.

The lack of east European technicians, who have left China without many replacements being provided by Russia (WORLD OIL, August 15, 1959, Page 256) in recent years is believed to be a bad blow to China's hamstrung oil industry.

The Turfan depression (see map, WORLD OIL, November 1960, Page 144) is believed to be oil-productive in both the Chinese Sinkiang region on the west and in the "Peoples Republic of Mongolia," another communist satellite on the east. Sinkiang's "Flame Hills" field was supposed to produce 2,000 bpd or more. Production is said to be from Jurassic to Tertiary strata.

On the Mongolian side, crude oil production of about 600 bpd is said

to have been established from lower Cretaceous sands near Sain Shanda close to the Chinese border. The field is thought to fulfill about 30 percent of Mongolia's oil needs.

The proposal by the current U.S. Administration to establish diplomatic relations with the "Peoples Republic of Mongolia," apparently to establish a northeast Asian listening post, is said to have drawn a strong negative reaction from China.

Taiwan . . . exploration is continuing

PETROLEUM EXPLORATION was continued in 1960 in Taiwan on the western plains and in the foothills. Since it was deepened in 1959, Well R-38 of Chinshui field, northern Taiwan, has been producing significant amounts of natural gas. That well has led to the drilling of more wells in Chinshui field. It also has encouraged Chinese Petroleum Corporation to prospect more actively for oil and gas in Taiwan.

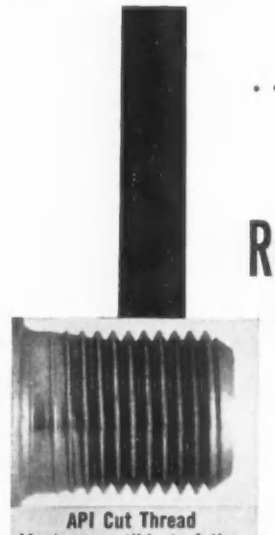
Drilling was carried on during 1960 in nine wells located in the foothills. Five of those wells were completed by the end of 1960. Four had not yet been completed at the end of the year and were still drilling in early March 1961. The total footage drilled during 1960 in all nine active wells was 51,260 feet. (See Table 1, Page 218.)

PETROLEUM EXPLORATION ACTIVITIES IN TAIWAN IN 1960

In dotted areas along the costs, sediments are relatively gently warped and possibly favorable for petroleum prospects. Mostly Tertiary or Mesozoic in age. Some Continental deposits. In solid areas in the interior, sediments are severely distored, metamorphosed, or otherwise unfavorable for petroleum production. Mostly Mesozoic or Paleozoic in age.

Exploration. Four geological parties conducted field mapping in 1960. Ten districts, covering a total area of 692 square kilometers or 170,996 acres, were mapped and studied (Table 2).

Geophysical prospecting included both seismic and gravity work. Two seismic crews carried out field work in six districts in the western part of Taiwan. They employed 2,316 shot holes, located at the profiles of a cumulative distance of 667 kilometers or 414 miles. One gravity party did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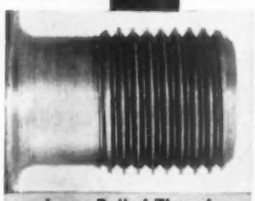
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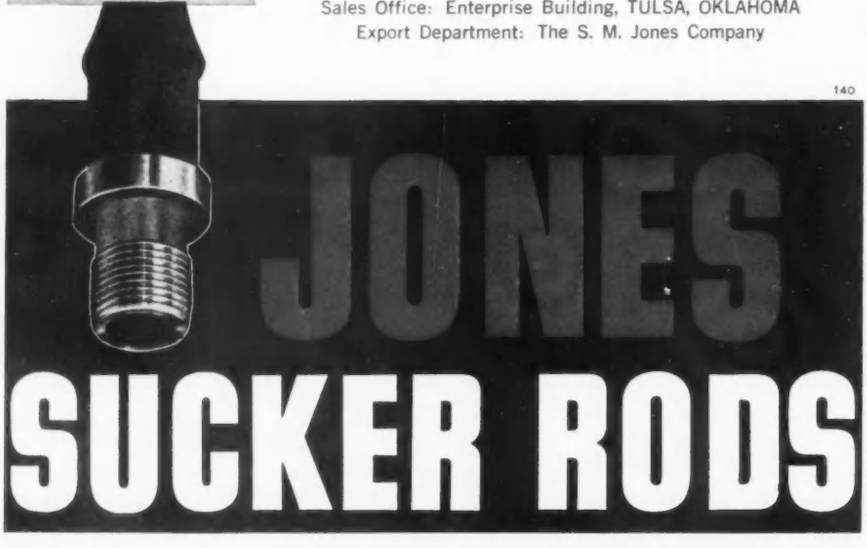

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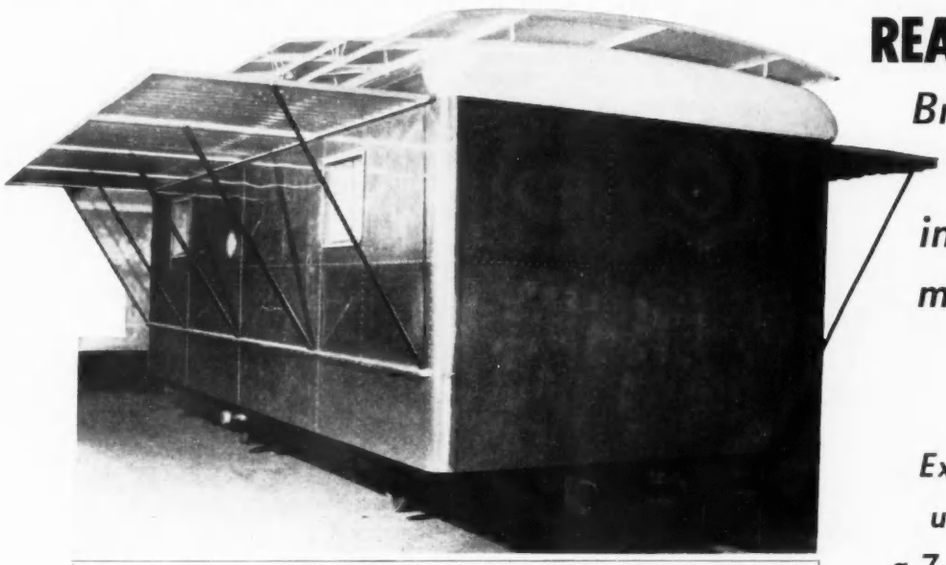

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its checking work in the northern part of Taiwan. It surveyed 5,280 points.

Crude oil production in Taiwan in 1960 totaled 14,188 barrels, an average of 39 barrels daily. It was about nine percent higher than in 1959. The production came from 35 wells, of which seven were flowing and 28 pumping. The wells were located in five fields, as shown in Table 3.

Natural gas production amounted to 812,900,000 cubic feet or 2,221,000 daily in 1960, a decrease of 11.8 percent from 1959. There were 26 gas producing wells in Taiwan in 1960. They were located in four fields.

Following the discovery of commercial gas production in Chinshui gas field, northern Taiwan, the Chinese Government decided to build an urea plant for making fertilizer, with natural gas as the raw material. The projected urea plant will require about 10,000,000 cubic feet of natural gas per day and will produce 100,000 metric tons of urea annually.

TABLE 2—Geophysical and Geological Surveying in Taiwan in 1960

METHOD	Number of Shot Holes or Points	AREA SURVEYED	
		Square Kilometers	Acres
Seismic	2,316	1,581	390,671
Gravity	5,280	1,221	301,714
Geological	.....	692	170,996

TABLE 1—Drilling in Taiwan in 1960
(All in Foothills)

Class of Wells	WELLS COMPLETED					Wells Drilling at Year End	Total Wells Active During Year	Total Footage Drilled During Year
	Oil	Gas	Dry	Total	Footage			
Development Wells	1	...	...	1	2,554		1	2,554
Deeper Pool Tests	...	...	...	...	.....	3	3	18,044
Wildcats	...	*2	2	4	30,000	1	5	30,662
Total	1	2	2	5	32,554	4	9	51,260

* One well was Chinshui 45, completed at 7,900 feet, flowing 2,100,000 cubic feet of gas and 6.5 barrels of crude per day through 13 64 inch choke, with bottom hole pressure of 3,300 psi. The other well was Chinshui 54, completed at 7,369 feet, flowing 2,800,000 cubic feet of gas daily through ¼ inch choke, with bottom hole pressure of 3,130 psi.

TABLE 3—Crude Oil and Natural Gas Production, Producing Wells, and Drilling in Taiwan in 1960

FIELD	Crude Oil Production, Barrels		Natural Gas Production, 1,000 cu. ft.		Crude Oil Producing Wells			Gas Producing Wells	Wells Drilling End of Year
	Year	Daily	Year	Daily	Flowing	Pumping	Total		
Chuhuangkeng	8,712	24	136,805	374	1	24	25		1
Chinshui	4,078	11	356,125	973	3		3	7	1
Chutung	43	...	117,005	320	1		1	4	1
Shantzechiao	968	3	560	1		2	2		
Niushan	...	...	120,925	330	...	...	...	11	
Chutouchi	387	1	81,480	223	2	2	4	4	
Wildcats	...	...	.....	.....	...	...	...	...	1
Total 1960	14,188	39	812,900	2,221	7	28	35	26	4
Total, 1959	13,046	36	921,693	2,525	7	27	34	31	7

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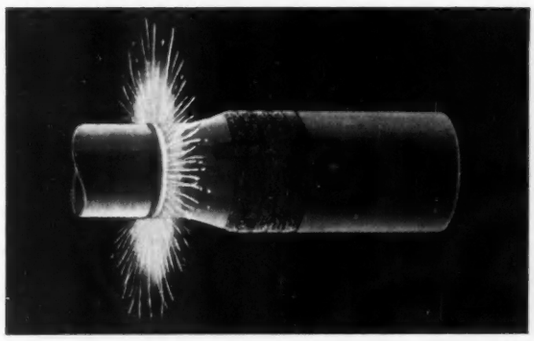

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Japan . . . new records set again in production of oil and gas, with aid of offshore development

RAPID STRIDES were made in Japan in 1960 and 1961 in oil and gas production, as exploration, particularly offshore in the Sea of Japan, northwest of the main island of Honshu, began to show tangible results. The drilling boom has continued to mount as the Japanese seek to keep pace with rising demands for fuel, both from domestic oil and gas sources and through liberalization of oil imports policies.

Production. Crude oil production reached an all-time high as it amounted to 3,730,019 barrels in 1960, an average of 10,191 bpd (Table 1). This represents an abrupt 30.2 percent increase over the 7,825 bpd rate of 1959.

Production from Niigata prefecture was more than doubled in 1960, compared with 1959. The 1960 crude oil yield from Hokkaido also was almost doubled. Production increased in Akita prefecture, too, but declined in Yamagata.

The gain or loss in crude oil production in the northwest Honshu prefectures was thus roughly proportional to the length of the coastline of each prefecture, an indication of the importance of offshore oil.

The increased crude oil output resulted mainly from boosts in yields from Sarukawa, Off Tsuchizaki (offshore), Mitsuke and Kubiki oil fields. A new pay discovered in Mitsuke proved very important. Significant crude oil reserves were developed in the thick Miocene green tuff, heretofore unproductive in Japan.

Japan Petroleum Exploration Co., Ltd. (Japex), made the first dual completion in Japan at Sarukawa SK14. Sarukawa oil field has six main pay zones. Further dual completions are expected to boost crude output rapidly.

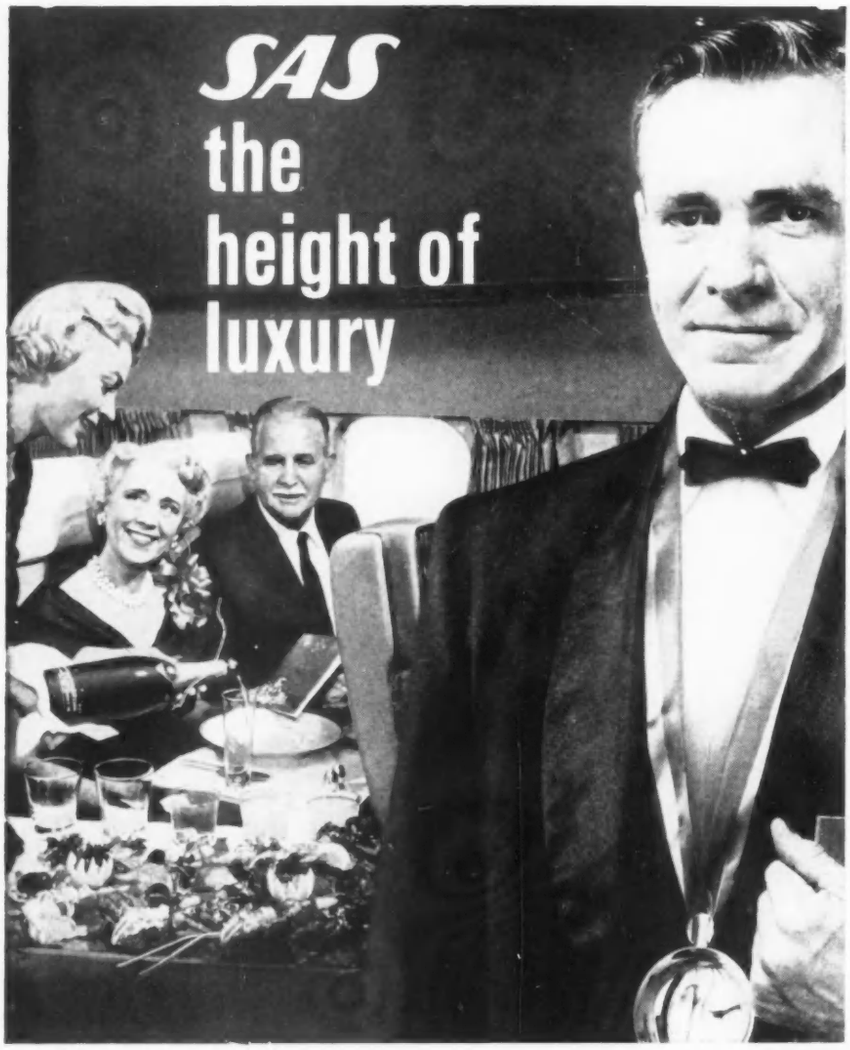
Natural gas production (Table 2) showed an even stronger increase than crude oil last year. Total yield was 25,819 MMcf in 1960, thus averaging 70,544 Mcfd, a boost of 4.5 percent compared to the 48,820 Mcfd

TABLE 1—Crude Oil Production in Japan in 1960, by Districts and Companies

PREFECTURE OR DISTRICT and Main Oil Fields			
Teikoku Oil Co. and Others	Japan Pet. Explo. Co. Ltd.	Total Barrels	Barrels Daily
AKITA: Yabase, Innai, Asahikawa, etc.	Sarukawa, Tsuchizaki offshore	2,356,630	6,439
NIGATA: Niitsu, Higashiyama, Kubiki, etc.	Tamugiyama, Mitsuke	1,164,417	3,181
YAMAGATA: Shonai, etc	Fukura, Amarume	130,203	356
HOKKAIDO: Ishikari, Azuma, etc.	Barato	78,543	214
OTHERS:		226	1
Total, 1960		3,730,019	10,191
Total, 1959		2,856,149	7,825

TABLE 2—Natural Gas Production in Japan in 1960, by Districts and Companies

PREFECTURE OR DISTRICT and Main Gas Fields		Thousand Cubic Feet	
Teikoku Oil Co. and Others	Japan Pet. Explo. Co. Ltd.	1960	1959
NIIGATA Niigata, Uchino, Aga, Nagaoka	Higashi-Niigata, Mitsuke	14,809,797	10,334,864
CHIBA Otaki, Mohara, Kanto		5,421,762	3,546,862
AKITA Yabase		4,514,199	3,272,217
OTHERS		1,073,367	665,229
Total		25,819,125	17,819,172
Daily		70,544	48,820



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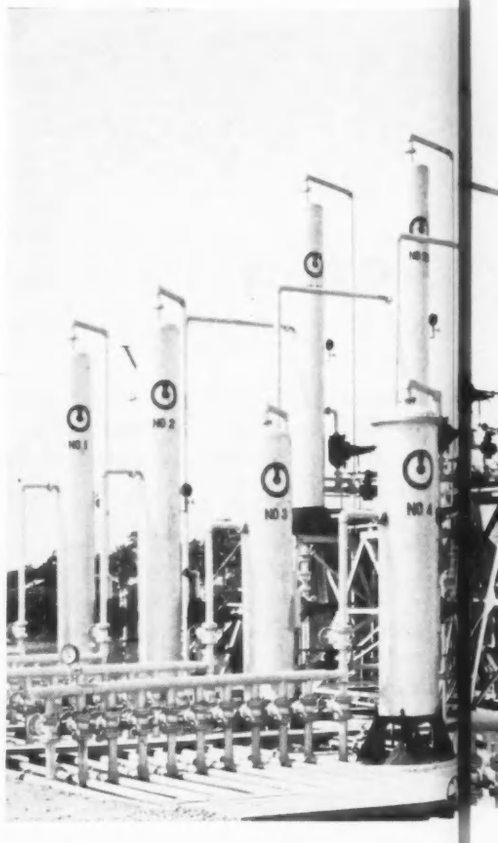
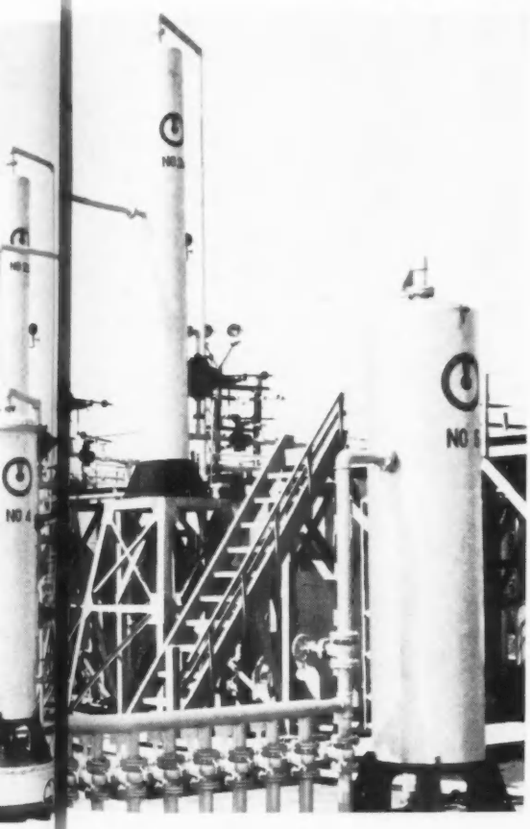
JAPAN

One of the tank batteries (above) and a rig drilling a well in Sarukawa oil field of Japan, facing the Sea of Japan.



Production facilities (below) in the Mitsuke oil field of Japan.

Photos courtesy of Japan Petroleum Exploration Co., Ltd.



rate of 1959. All gas-producing provinces, including Chiba prefecture near Tokyo, scored gains over 1959 totals.

The increase in natural gas production was largely due to discovery and development of new fields, and was effected in spite of the recent prohibition of production of high water content gas in Niigata prefecture, where excessive extraction of such reserves caused land submergence.

Drilling. Completions soared to 387 new wells in 1960, an increase of 70, or 22.1 percent compared to the 317 completions made during 1959 (Table 3). There were 137 new oil wells, up 50 from the 1959 total (87); also 169 new gas completions, up 11 from the 158 gassers completed during the previous year. Exploratory footage dropped to 273,916 feet in 1960, down 161,003 feet or 37.0 percent from the 434,919 feet of exploratory hole tabulated in 1959. But development footage last year increased to 1,126,269 feet, up 400,415 feet or 55.2 percent compared to the 1959 figure. Over-all 1960 footage was up 20.6 percent compared with 1959.

Average depth of wells completed in 1960 was 3,618 feet, slightly shallower than the 1959 average of 3,662 feet.

Exploration. Teikoku Oil Co. conducted exploration mainly in Kanto district along Honshu's east coast and discovered some new gas fields in Chiba prefecture.

Japex found the Amarume oil field in Yamagata and Yasuda, Katagai, Sekihara, Ojiya Sanjo and Higashi-Sanjo gas fields in Niigata. Katagai SK-1 initially produced 14 MMcfd on a 12-mm (about ½-inch) choke and was considered the largest 1960 gas find.

Offshore exploration and development continues to show favorable results. Off Tsuchizaki SK1, offshore from Akita prefecture, a producing well found and capped in 1959, was confirmed as a significant oil discovery in 1960, when Japex completed two additional, similar wells from the same platform. In May 1961, these three wells were producing 500 barrels daily into a tank farm on the Akita shore via a 4½-inch submarine pipe line. Wells SK4, 5 and 6 were also drilled last year from the platform which had been moved 1,640 feet south of the original site. Commercial oil in quantities similar to the earlier wells were found in all three, but commencement of production was postponed through the winter until the spring of 1961.

After it was indicated that Kubiki oil field, found in Niigata in 1959, extends seaward, Teikoku Oil Co. built an artificial island of 500 square meters (5,382 square feet) connected with shore by a bridge 945 feet long. Teikoku was drilling the first well from this island in May 1961. (For other offshore data, see WORLD OIL, June 1961, pp. 82-83.)

A marine sonar probe survey has recently been completed in Japan.

Pipe line. The U.S. embassy in Tokyo was quoted in the *Foreign Commerce Weekly* as reporting a natural gas pipe line project planned by Teikoku, from Kubiki field to Tokyo. This 215-mile, $13.9 million line was to be completed in 1962, and was to deliver 17.7 MMcfd from the Kubiki area to Tokyo Gas Company.

Demand. Oil consumption in Japan reached 171.5 million barrels in 1960, up about 38 percent compared to 1959. Rapid growth of the petrochemical industry was a key factor in this increase. About 2.2 percent of oil demand was met by domestic crude in Japan in 1960.

Oil demand in Japan is expected to continue increasing very rapidly and to amount to 630 million barrels (1,725,000 bpd) by 1970.

Refining. Japanese refining capacity at the end of 1960 increased to 730,000 bpd, up 15.5 percent from the 632,000 bpd capacity at the end of 1959.

TABLE 3—Drilling Activity and Producing Wells in Japan in 1960

	Wells Completed			Footage Drilled			Wells in Progress at End of Year			Status of Wells at End of Year					
Tests	Producer	Dry	Total	Exploration	Exploitation	Total	Drilling	Testing	Total	Fields	Producer	[1]Sec. Recov.	[2]Shut In	Total
Oil	137	60[3]	197	206,314	632,562	838,876	25	4	29	Oil	2,682	36	538	3,256
Gas	169	21[4]	190	67,602	493,707	561,309	13	3	16	Gas	1,082	81	269	1,432
Total	306	81	387	273,916	1,126,269	1,400,185	38	7	45		3,764	117	807	4,688

[1] Secondary Recovery Wells. [2] Or suspended. [3] Some dry holes are in primarily oil producing areas. [4] Some dry holes are in primarily gas producing areas.

Indonesia . . . crude production up in 1960 but development is retarded by political situation

INDONESIA'S OIL INDUSTRY continued with the momentum of previously established trends in 1960 and early 1961. Total crude oil production increased by 9.4 percent last year to 411,228 bpd, largely because of a 22.7 percent boost from Caltex Pacific Oil Co.'s central Sumatra fields (Table 1) to more than 200,000 barrels daily, and despite a decrease in output by Stanvac. Production is increasing in the old Shell concessions in north Sumatra under operation of a Japanese group which has advanced credits to rehabilitate these fields in return for crude to be produced. Drilling in north Sumatra was to be renewed by the end of 1961.

A new oil law, very vague and general in nature, was signed by the president of Indonesia on October 26, 1960. It left private oil concessionaires in Indonesia in an uncertain legal position as of mid-year 1961, with their actual legal operating and tax status terminated as a practical matter. It was not known what future terms the government will impose, nor to what extent retroactivity will apply.

In the meantime the 1960 contract with the Japanese for north Sumatra has become fully known, and operations were proceeding there.

Shell affiliates. Two firms are involved in operating the old Royal Dutch Shell concession areas in south Sumatra, Java, and Kalimantan (Indonesian Borneo), Permindo and P. T. Shell Pertambangan Minjak Indonesia. Twenty-six oil fields were produced last year (Table 2), 19 by P. T. Shell and 7 by Permindo. Seventeen were in south Sumatra, 7 in Kalimantan, and 2 in Java. Crude oil production totaled 43,070,710 barrels or 117,678 bpd, a decrease of 0.5 percent from the 1959 rate of 118,271 barrels daily. Production was from 1,416 oil wells, 202 of them flowing and 1,214 on artificial lift.

Drilling declined last year; forty-four development wells were completed including 39 oil wells and 5 dry holes aggregating 157,912 feet of hole. There were three wildcats, all dry, completed in 1960 by P. T. Shell, one each in South Sumatra, East Java, and east Kalimantan in the following order. Ketaling 2 bottomed at 4,435 feet in basement. Tobo 8 went to 4,753 feet in Miocene, and Kambitin 3 was in basement at total depth of 4,185 feet.

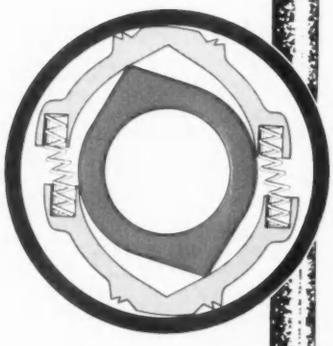
The 47 wells completed in 1960 amounted to 171,285 feet of hole, compared to 61 wells and 305,214 feet in 1959. P. T. Shell had two development rigs operating in Tandjung field in Kalimantan at the end of 1960, where 17 wells were completed last year. A 160-mile, 20-inch crude oil pipe line was slated for late 1962 completion to connect Tandjung field with the Balik Papan refinery.

Permindo had a rig active on a wildcat at the end of December. During the period 1947 through 1960, P. T. Shell has completed 51 wildcats and Permindo 17.

In other exploration, P. T. Shell conducted 12 party months of seismograph work last year.

Refining activity by P. T. Shell remained status quo. Capacities of its four Indonesian plants were listed as follows at the end of December: Pladju, 110,000 bpd; Balikpapan, 75,000; Tjepu, 4,600; and Wonokromo, 3,200 bpd. Crude oil intake in these refineries during the last half of 1960 averaged 99,300; 48,800; 2,400; and 3,100 barrels daily respectively, totaling 153,600 barrels daily.

Caltex. Production from the prolific Minas field is being continually increased to market demand. Most of the 1960 yield of 74,384,186 barrels (203,235) daily was from Minas, and compares with 165,674 bpd from Caltex' central Sumatra concessions during 1959. Production continued to climb in 1961. Caltex reported crude oil production of 32,240,441 barrels or 213,513 barrels daily during the first



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five months of 1961, compared to 186,811 bpd during the same period in 1960. Production from Minas was running at about 170,000 bpd in April 1961, and at Duri field, about 30,000 bpd. Regarding Bekasap and Pematang fields, the latter may be commercial; but plans to exploit it more fully were being deferred pending clarification of the concession's status.

Caltex continued its development drilling program last year, concentrating on the shallow (800 feet) Duri field. Seventy-seven new oil wells were completed. Three wildcats, Sebango Bow, Semunai 1, and Semunai 3 all bottomed last year without establishing production. The 80 wells amounted to about 65,000 feet of hole. By the end of 1960, Caltex had completed 444 wells in Sumatra, 413 of them oil wells. There were no gas wells. About 336 of the oil wells were believed to be on production as of last December 31. As of April 1961 about 265 wells had been completed in Duri field.

In other exploration, Caltex conducted 18 seismic crew months and 12 party months of gravity work last year.

Stanvac. Routine production operations continued in the Lirik fields of central Sumatra and the Talang Akar-Pendopo area of south Sumatra. Stanvac's average production of 77,929 bpd in 1960 was 5.5 percent below the 1959 average of 82,447 bpd, though last year's output compares favorably with the 1958 yield (75,157 bpd). Stanvac reported 569 oil wells producing and 221 shut in at the end of 1960. Much production was on gas lift.

Stanvac drilled actively last year, though no rigs were reported working at the end of December. Fifteen development wells, including 12 oil wells and three dry holes aggregating 36,200 feet of hole were completed; and in wildcats, there were 3 oil completions, 1 gas, and 10 dry, aggregating about 40,000 feet of hole. Stanvac also conducted 19 party months of core drilling.

Construction of the gas pipe line in south Sumatra from Radja field to Palembang was expected to begin late in 1961 (WORLD OIL, August 1, 1961, pp. 99-104). Workover of several wells in Radja field to fulfill gas production requirements is also involved in this project.

Daily average crude runs at the Sungei Gerong refinery, rated at 77,000 bpd capacity, amounted to 74,400 barrels last year.

Permina. Crude oil production last year in north Sumatra by Permina, the Indonesian government agency,

TABLE 1—Crude Oil Production, Producing Wells, and Drilling in Indonesia in 1960, by Companies

COMPANY	CRUDE OIL PRODUCTION					Producing Oil Wells Yr. End	WELLS COMPLETED				
	Total Barrels		Barrels Daily				Wells				Total Footage
	1960	1959	1960	1959	% Diff.		Oil	Gas	Dry	Total	
Caltex Pacific Oil Company	74,384,186	60,470,994	203,235	165,674	+22.7	336*	77	0	3	80	65,000*
Royal Dutch Shell group members	43,070,710	43,169,060	117,678	118,271	— 0.5	1,416	39	..	8	47	171,285
Standard-Vacuum Petroleum Mij.	28,522,071	30,093,137	77,929	82,447	— 5.5	569	15	1	13	29	76,200
Permina	4,533,333	3,520,000*	12,386	9,644	+28.4	69	...		...	...	...
Total, Indonesia	150,510,300	137,253,191	411,228	376,036	+ 9.4	2,390	131	1	24	156	312,485
Total, Indonesia, 1959	.....	.....	.....	.....	.....	2,159	113	1	28	142	420,403

* Estimated.

TABLE 2—Royal Dutch Shell Group's Crude Oil Production, Producing Wells, and Development Drilling in Indonesia in 1960, by Fields and Companies

Field and Location	Company	Year Discovered	Crude Oil Production			Producing Wells Year End	Wells Completed					Wells Drilling Year End
			Total Barrels in Year	Bbls. Daily in Yr.	Bbls. Daily in Dec.		Oil	Gas	Dry	Total Wells	Total Footage (Feet)	
JAVA												
Kawengan	P.T. Shell	1926	1,365,080	3,730	3,610	76[1]	..	..	..	..	594	....
Kruka	P.T. Shell	1929	159,920	437	460	44	..	..	..	..	.....	....
KALIMANTAN												
Anggana-Muara	P.T. Shell	1902	423,700	1,158	1,110	80[2]	..	..	..	..	.....	....
Balik Papan	P.T. Shell	1903	1,890	5	.....	1	..	..	..	..	.....	....
Bunju	Permindo	1930	3,794,410	10,367	10,280	44[3]	..	..	..	..	.....	....
Sambodja	P.T. Shell	1910	239,300	654	640	48	..	..	..	..	.....	....
Sanga Sanga	P.T. Shell	1897	809,990	2,213	2,240	81[4]	..	..	..	..	.....	....
Tandjung	P.T. Shell	1938	111,170[5]	304[5]	190	.....	16	..	1	17	75,075	2
Tarakan	P.T. Shell	1906	1,108,310	3,028	2,790	371	..	..	..	..	.....	....
S. SUMATRA												
Babat	P.T. Shell	1901	7,400	20	.....	11	..	..	..	..	.....	....
Badjubang	Permindo	1927	686,650	1,876	2,180	35	4	..	1	5	17,115	....
Gunung Kemala	P.T. Shell	1938	796,290	2,176	2,150	12	..	..	..	..	.....	....
Keban	P.T. Shell	1941	52,260	143	110	2	..	..	..	..	.....	....
Kenali Asam	Permindo	1931	3,538,950	9,669	8,780	128	11	..	..	11	27,500	....
Limau	P.T. Shell	1928	17,757,930	48,519	46,870	120	2	..	3	5	24,492	....
Mangundjaja	P.T. Shell	1935	525,080	1,435	1,550	37	..	..	..	..	.....	....
Meruo Senami	Permindo	1938	23,480	64	60	2	..	..	..	..	.....	....
Prabumulih West	P.T. Shell	1953	373,220	1,020	910	4	..	..	..	..	.....	....
Sei Taham	P.T. Shell	1903	20,090	55	120	4	..	..	..	..	.....	....
Setiti	Permindo	1936	280,350	766	740	14	..	..	..	..	.....	....
Suban Djerigi	P.T. Shell	1905	106,550	291	430	21	..	..	..	..	.....	....
Sungei Gelam	Permindo	1958	22,290	61	60	2	..	..	..	..	.....	....
Talang Djimar	P.T. Shell	1937	5,220,430	14,263	15,460	121	1	..	..	1	....[6]	....
Tandjung Tiga	P.T. Shell	1940	2,846,610	7,778	7,380	47	2	..	..	2	....[6]	....
Tempino	Permindo	1931	2,450,480	6,694	5,730	107	3	..	..	3	13,136	....
W. Tandjung Miring	P.T. Shell	1938	348,880	952	860	4	..	..	..	..	.....	....
Total for Group in Indonesia	.....	.....	43,070,710	117,678	114,710	1,416	39	..	5	44	157,912	2
Total in 1959	.....	.....	43,169,060	118,271	118,614	1,434	48	1	6	55	273,422	3

[1] All on pump. Figure excludes 2 gas wells. [2] All on pump. Figure excludes 1 gas well. [3] 39 flowing and 5 on artificial lift. Excludes 1 flowing gas well. [4] All on pump. Excludes 5 gas wells. [5] Production for local use only. [6] Footage included in figure for Limau.

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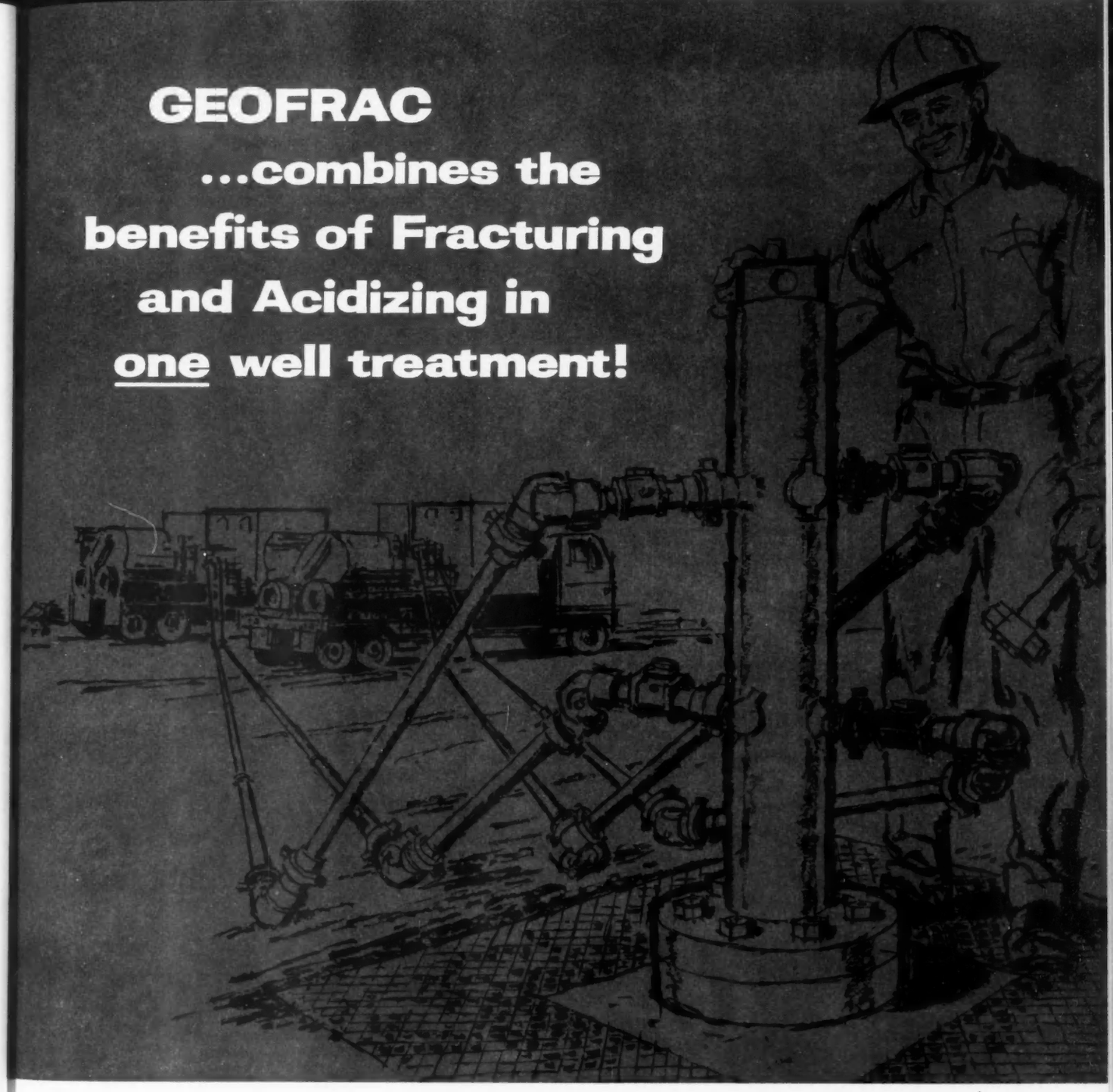

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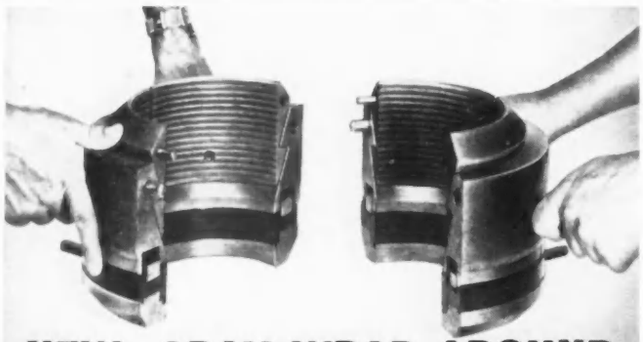

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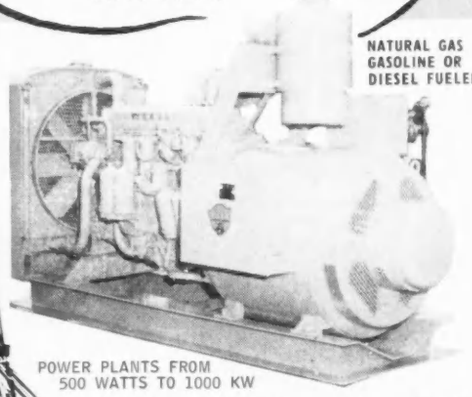

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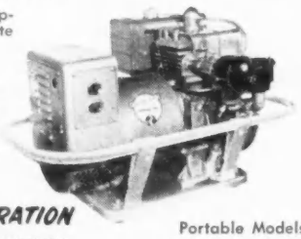

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was put at 4,270,894 barrels from 68 flowing wells at Rantau field and 262,439 barrels from one flowing well at P. Tabuhan. These fields combined thus averaged 12,386 bpd in 1960.

The Royal Dutch Shell companies operating in the area before World War II reported that 55,513,000 barrels (cumulative) were produced from the Miocene-age Keutapang sands from 1,040 to 2,560 feet, with 125 wells drilled on the Rantau anticline. Cumulative production by Shell at P. Tabuhan field, a 1937 discovery, was 3,283,000 barrels from the same formation from 3,300-3,500 feet, with 40 wells having been drilled prior to 1942.

The Brandan refinery operated at limited capacity last year, about 1,200 bpd to fulfill local needs.

North Sumatra Oil Development Cooperation Co. was established in Japan on June 1, 1960 to work with Permina to develop the north Sumatran fields. Production in 1961 is to be increased more than 6 million barrels (16,500 bpd). Thirty new producers were to be completed in Rantau and P. Tabuhan fields. New drilling equipment was expected to arrive in Sumatra before the end of 1961.

New law. Though the law signed by President Sukarno on October 26 will have to be amended by further, more specific oil legislation, it evidently outlines some general future policies. Oil and gas mining will be undertaken only by the state. The state may employ foreign experts in oil and gas enterprises. Private firms whose oil rights were obtained pursuant to previous regulations "can be exercised during a limited period which shall be as short as possible, determined by government regulation." Such previous enterprises will be given priority in considerations regarding appointment of contractors to currently producing areas.

Only state enterprises will be allowed to manage oil and gas production, and such rights will be much different from former concession rights.

Japanese contract. Since this unique agreement was partially summarized in last year's report (World Oil, August 15, 1960, pp. 274-276),

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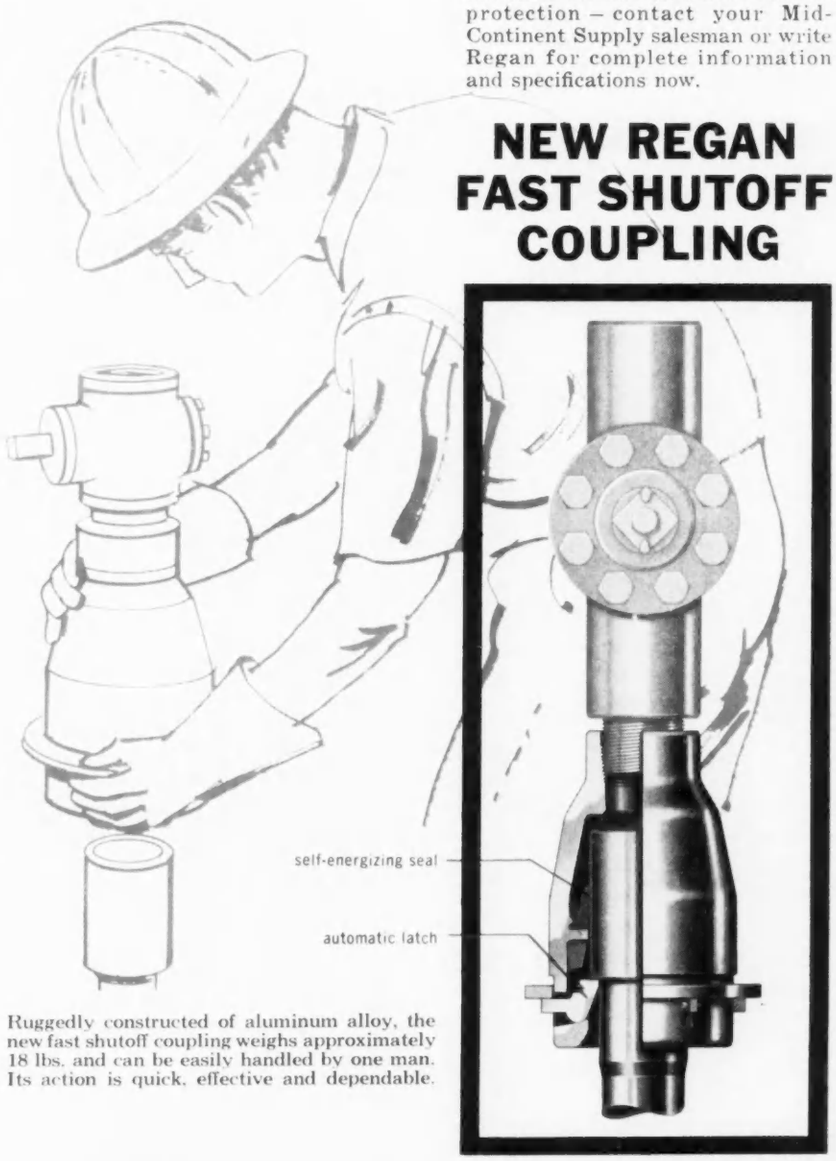

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the full English text has become available. It is interesting not only as a forecast of future development in the north Sumatra operating area but also as an indicator of the type of contracts the government may approve in the future.

Parties to it are P. T. Perusahaan Minjak Nasional of Indonesia (Permina) and the Kobayashi group of Japan. It covers the areas of Permina's mining rights in North Sumatra and Atjeh. Effective date is June 1, 1960, for 10 years. Purpose is to raise crude oil production to 2.5 million kiloliters annually (15,722,500 barrels, or 43,075 bpd). Kobayashi is to provide Permina with credit in Japanese Yen equivalent to $52,347,222 in the form of equipment, materials, techniques and services. Permina will provide Rupiah funds to carry out reconstruction and development of the oilfields.

Production capacity at the time of agreement was put at 800,000 kl annually (5,031,200 barrels or 13,784 bpd). Annual crude output is to be determined by a committee at the start of each year, the first one excepted. Each year (except the first) Permina will deliver to Kobayashi 40 percent of the annual crude oil output which exceeds the basic production figure (800,000 kl, or 13,784 bpd).

After crude output reaches 2.5 million kl annually (43,075 bpd) Permina will deliver to Kobayashi 680,000 kl or the equivalent of 40 percent of the excess of the 2.5 million kl over Permina's basic production as long as Permina's yearly output falls within 2.3 and 2.6 million kl (39,629 to 44,798 bpd).

The total value of crude to be delivered by Permina during the term of the agreement shall not be less than the total amount of credit provided by Kobayashi. The stated price of crude will be tied to existing international market prices and will be f.o.b. Pangkalan Susu.

Rights provided by the contract cannot be assigned to third parties without the consent of both contractees. There is a *force majeure* clause (Article 18) and certain arbitration provisions.

North Borneo . . . operations status quo; production declines; offshore oil sought

ROUTINE OPERATIONS dominated the oil picture in British Borneo during 1960 and early 1961. Crude oil production averaged 92,909 bpd, down 16,877 barrels daily (15.4 percent) from the 109,786 barrels daily average of 1959. Total crude oil yield last year was 34,004,787 barrels, 98.3 percent of it from Seria field. Daily average production at Seria last year was 91,414 bpd, down 16,985 bpd or 15.7 percent from the 108,399 bpd average of 1959. Further future decline in Seria production was indicated by the December 1960 average production of 86,680 barrels.

Otherwise, little was reported from North Borneo except the statistical data (see accompanying table). A marine sonar probe survey was completed in North Borneo as the search for oil beneath the South China Sea continued.

Sarawak Shell completed its Enkabang 1 wildcat, reported drilling at 10,854 feet at the end of 1959, at 11,068 feet in 1960. Enkabang 2 was drilled to 1,600 feet and Ensalai 1 to 9,289 by the same company. Brunei Shell drilled East Jerudong 1 to 10,343 feet. No positive results were announced from any of these wildcats.

Producing depths in Seria field were increased slightly last year, to 10,452 feet at the end of 1960 compared with 10,201 feet as of a year earlier.

A comprehensive description of the geology of more than 58,000 square miles of British North Borneo was published recently, pursuant to a joint project between the operating Shell group companies and the Government Geological Survey Department.

North Borneo's lone refinery, the Lutong plant run by Sarawak Shell continued to operate at its approximate capacity, charging about 46,000 bpd during 1960.

Crude Oil Production, Producing Wells, and Development Drilling in North Borneo in 1960

(All by Royal Dutch Shell group companies)

Country	Brunei	Brunei	Sarawak	Total British Borneo
Company	Brunei Shell Petroleum Company Limited	Brunei Shell Petroleum Company Limited	Sarawak Shell Oilfields Limited	
Field (or producing area) Year of discovery	Seria 1929	Jerudong 1955	Miri 1911	
Footage drilled in 1960, feet	66,114			66,114[1]
Wells completed in 1960	13			13
a. Oil wells	11			11
b. Gas wells				
c. Dry holes	2			2
d. Suspended				
Wells actually drilling at end of 1960	1			1
Drilling wells suspended at end of 1960	2		5	7
Total producing wells at end of 1960	343	2	179	524
Flowing wells	104	2		106
Pumping wells	30		179	209
Other artificial lift wells	209			209
Total wells drilled to end of 1960	534	9	618[2]	1,161
Producing depths at end of 1960, feet	834–10,452	3,523–4,021	300–6,270	
Crude oil production in 1960, barrels	33,457,428	114,046	433,313	34,004,787
1960 crude production, bbls. daily	91,414	311	1,184	92,909
Crude oil production in Dec. 1960, bbls. daily	86,680	269	1,203	88,152
Cumulative crude oil production to end of 1960, barrels	518,643,735	523,852	75,943,150	595,110,737
Base of crude	Mixed	Mixed	Mixed	
API gravity of crude	10–48°	40–42°	17–46°	
Age of producing formation	Tertiary	Tertiary	Tertiary	
Kind of producing formation	Sand	Sand	Sand	

[1] Not including exploratory wells Engkabang 1 drilled to 11,068 feet, Engkabang 2 drilled to 1,600 feet, Ensalai 1 drilled to 9,289 feet (by Sarawak Shell) and East Jerudong 1 drilled to 10,343 feet by Brunei Shell.
[2] Includes 9 twin wells.

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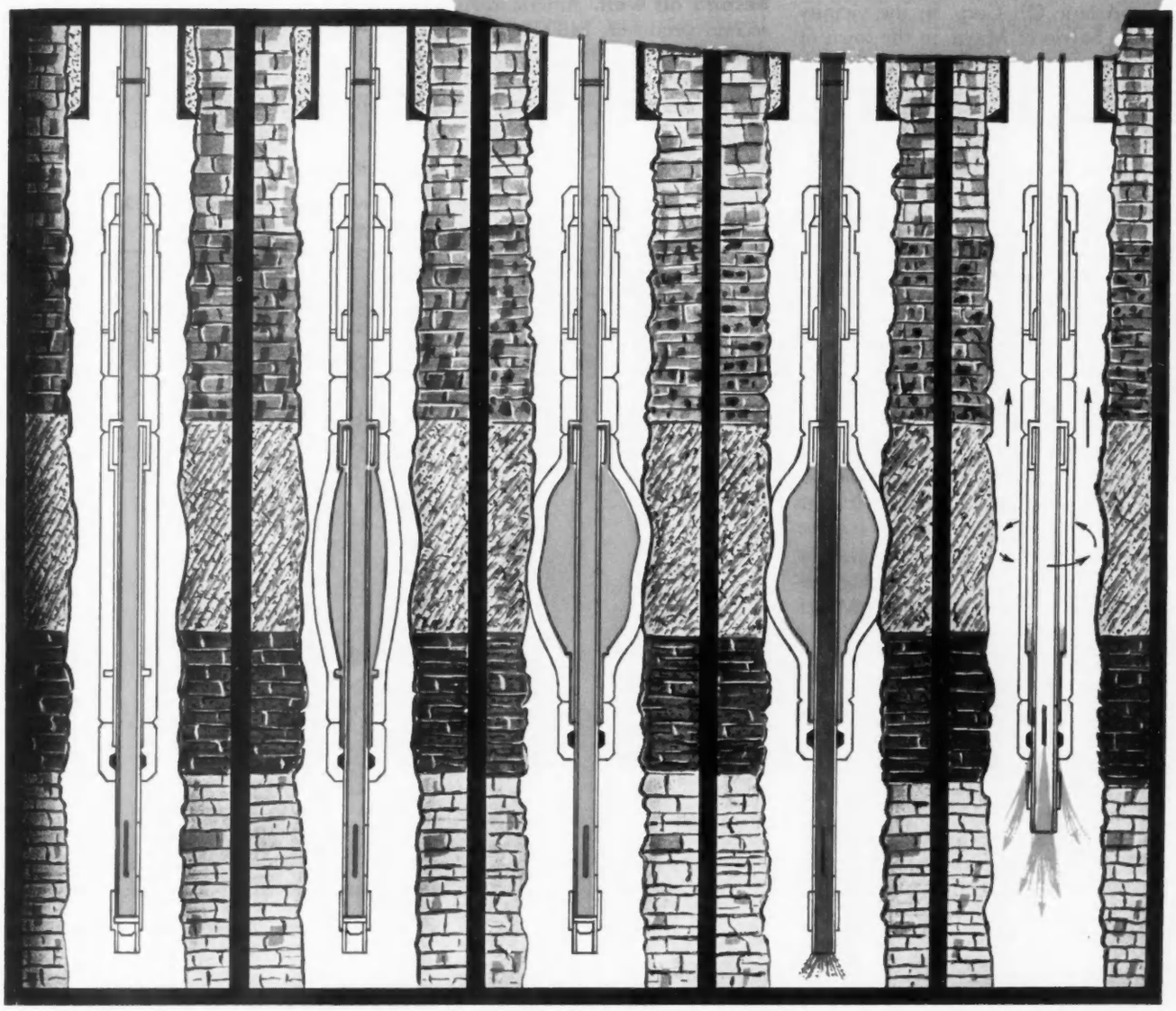

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Philippines . . . second oil field found in 1961; first in 1959. Two areas have gas wells

THE PHILIPPINES gained a second oil field in early spring 1961, following the first oil discovery in 1959 and two gas discoveries in 1958. The new oil field is being developed by American-Asiatic Oil Corp. in the vicinity of the barrio of Maya, in the town of Daanbantayan, northern Cebu Island, central Philippines.

The company completed its discovery well, DST-1, on April 27, 1961, at 990 feet. The well had encountered oil and gas in four zones, at 235-250 feet, 550-570 feet, 683-707 feet, and 975-990 feet. The formations were sandy shales of middle Miocene age. The well flowed for about 45 hours during five production tests of the first oil zone at 238-244 feet.

From the discovery well 80 drums of oil were sent to Standard Vacuum Oil Co.'s Bataan refinery for testing. The oil was of good quality and high grade. The paraffin content would not be a production problem, it was stated.

DST-1 started drilling March 4, 1961, using a small core drilling machine and not an oil rig. On March 10, 1961, at 238-244 feet it had a blowout, with oil under pressure reaching a height of about 30 feet. In four hours the crew controlled the well.

Subsequently, during five production tests on several days, oil flowed continuously, without the use of pumps, at rates ranging from 30 barrels daily through a 6/64 inch choke up to 144 bpd through a ¾ inch choke. The well flowed for a total of over 45 hours during the testing. When closed in and not flowing, it had a well head pressure of about 65 pounds.

Following the production tests, an oil well drilling rig was brought to the site to replace the core drilling machine. Drilling then continued on to 990 feet, and found the three additional oil and gas zones.

Second oil well. American-Asiatic's second producer, MST-11, was completed May 24, 1961. It was described as the first free flowing oil well in the Philippines. After a series of production tests, it was figured that the best was the one that actually produced 60 barrels per day with oil flowing through an opening of 3/16 inch diameter and a flowing pressure of 47 pounds.

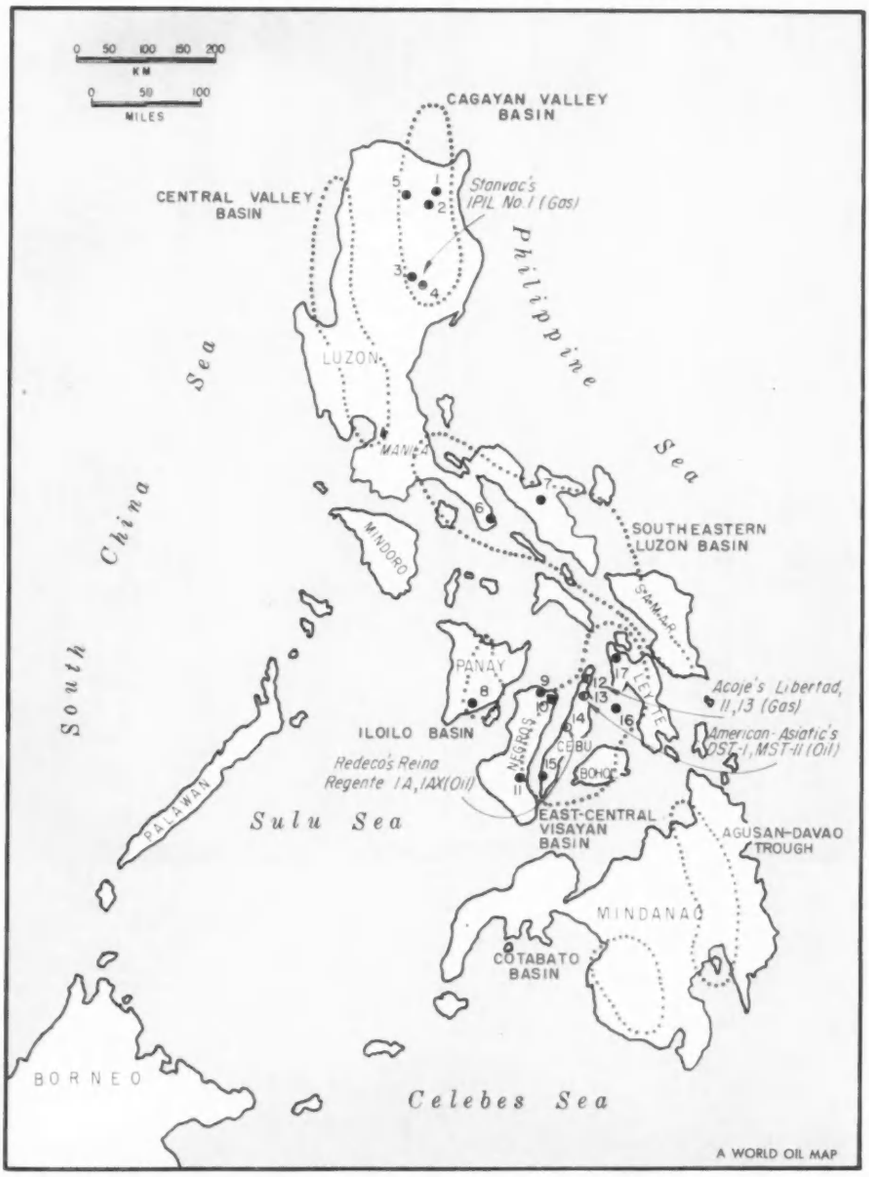
One test lasting for 8 hours and using a ½ inch diameter opening produced 120 barrels, or at the rate of 360 barrels per day, but the flowing pressure was only 18 pounds. The technical staff said a high production at low pressure would adversely affect the reservoir and hasten the use of pumps for production, and a lower

TABLE 1—Drilling in the Philippines in 1960 and 1959

ITEM	1960	1959
Wells Completed, Total	38	15
Oil Wells		2
Gas Wells		
Dry Holes	38	13
Footage Drilled	103,906	72,828
Average Depth	2,734	4,855
Wells Drilling at Year End	2	4

PHILIPPINE EXPLORATORY WELLS

Showing 1960-1961 wells and previous discoveries, as listed in Table 2. Areas where oil and gas have been discovered are shown in green.



The Philippines have had oil and gas well completions in four areas as follows: 2 oil wells in northern Cebu in 1961, 2 oil wells in central Cebu in 1959, 2 gas wells in extreme northern Cebu in 1958, and 1 gas well in northern Luzon in 1958.

production rate at steady pressure would eventually be cheaper.

This well flowed at least 100 hours before it was closed in, and it then had a well head pressure of about 65 pounds, as did the discovery well. From this second well, 100 drums of oil were moved to Cebu City for transshipment to Stanvac's Bataan refinery for further testing, and 250 additional drums were still in the MST-11 yard for haulage to Cebu City.

After completion of MST-11, American-Asiatic Oil Corp. directors in early June 1961 decided upon the drilling of more shallow wells and the purchase of a new rig of 2,000 feet capacity for developing the oil reservoir encountered in DST-1 and MST-11. In addition, arrangements were being made to rent a rig that could go down to about 5,000 feet for exploring probable lower oil horizons and possibly drilling down to basement rock.

The depth of wells to develop this reservoir in the vicinity of Maya would vary approximately from 200 to 1,000 feet. The national road within the area is well maintained, and most of the proposed well locations are within 2,000 feet from the national highway and the sea coast. The concession is almost surrounded by the Visayan Sea. Hence, shipment of any future production would not be a problem. These favorable field conditions should greatly reduce production costs. If future wells would yield an average of only 30 barrels per day, oil could be produced commercially in this area, according to a statement by Leonides S. Virata, president of American-Asiatic.

American-Asiatic was using a core drilling machine when it found oil in the discovery well, DST-1, at about 244 feet. It then brought in a larger rig, which was used to finish drilling that well and to drill MST-11. The company continued to use the core drilling equipment to drill several additional shallow tests in the same area. Three of them were finished in April and May, and a fourth was in progress in late April.

These shallow structural holes all revealed the presence of oil at the shallow horizon touched by the original discovery well. The most significant finding was the gas encountered in one of the holes between 292 and 317 feet. The gas pressure at 317 feet was 135 pounds. Because the core drilling equipment was not safe to proceed with drilling under such pressure, the hole was plugged. This gas reservoir was considered to be above and different from the 235-250 foot oil horizon of DST-1.

These wells were believed to be near the axis of an anticlinal structure. It was thought that there was a need for additional deeper holes to prove the extension of this structure. Drilling plans called for exploring further the first oil horizon encountered in DST-1. In addition, a few holes to explore possible oil horizons below 1,000 feet were being considered.

While drilling in northern Cebu, American-Asiatic Oil Corp. also carried out drilling on Bantayan Island, off the northwestern coast of Cebu. Drilling was started there on February 20, 1961.

More drilling in Philippines. Extensive geological and geophysical data were recorded in the Philippines in 1960 and early 1961 in addition to the finding of oil in northern Cebu. Wildcat drilling was increased, and geological and geophysical work proceeded actively.

During 1960, operators completed 38 wells with combined depths of 103,906 feet, an average of 2,734 feet per well. That compared with 15

TABLE 2—Philippine Exploratory Wells

This table includes wells completed in 1960 and early 1961. Also listed are 5 wells completed in 1958 and 1959 as gas and oil producers. Locations of all wells are shown on map herewith, by means of key numbers.

Basin and Island, Company and Well	No. On Map	Date Completed	Results	Depth, Feet
Cagayan Valley Basin, N. Luzon				
Standard Vacuum Oil Co., Paret 1	1	9-15-60	dry	5,500
Narra 1	2	7-13-60	dry	6,123
Rizal 1	3	5-17-60	dry	9,236
Ibil 1	4	7-25-58	gas well	7,260
Texas Overseas Pet. Co. & California Asiatic Oil Co., Illuru 1	5	1-12-60	dry	10,243
S. E. Luzon Basin, S.E. Luzon				
Philippine Oil Dev. Co., Bondoc 7	6	12- -60	dry, sg	4,262
Philex-Baguio Gold, Santo Nino 1	7	1-15-61	dry	600
Santo Nino 1-A	7	2-15-61	dry, sog	1,500
Iloilo Basin, Panay				
Philippine Oil Dev. Co., Tigbauan 1	8	1-11-60	dry, sg	7,485
San Miguel 1	8	5- 2-60	dry, sg	7,272
E. Cent. Visayan Basin, N. Negros				
Anglo Philippine Oil Corp., Sagay 1	9	7-26-60	dry	1,304
Maremco Mineral Corp., Fuentes 1	10	5-15-60	dry, sg	1,709
E. Cent. Visayan Basin, S. Negros				
Anglo Philippine Oil Corp., Bagtic 1	11	5-21-60	dry	457
Bagtic 2	11	7-21-60	dry	780
E. Cent. Visayan Basin, N. Cebu				
Acoje Oil Exploration, Libertad 11	12	7-21-58	gas well	721
Libertad 13	12	8-22-58	gas well	575
American-Asiatic Oil Corp., DST-1, discovery well	13	4-27-61	oil well	990
MST-3, 650 ft sw DST-1	13	3- -61	dry, so	165
MST-4, 1,300 ft ne DST-1	13	4- -61	dry, so	41
MST-5, gas, 135 psi, at 292-317 ft	13	4 -61	dry, sog	317
MST-11, near DST-1	13	5-24-61	oil well	1,000 (?)
E. Cent. Visayan Basin, cent. Cebu				
Acoje Oil Exploration, Malolos 1	14	8-15-60	dry, sog	9,017
Malolos 2	14	12-15-60	dry	2,009
Malolos 3	14	2-15-61	dry	953
E. Cent. Visayan Basin, cent. Cebu (Continued)				
Republic Resources & Dev. Corp., Villalon 1, about 2,900 ft. N. W. of oil wells	14	2- 4-60	dry	3,639
Parahinog 1	14	2-21-60	dry	1,995
Villalon 2, nw of prod.	14	4-15-60	dry	1,815
Reina Regente 2-A, 910 ft. from oil wells	14	5-16-60	dry, sog	2,600
Reina Regenta 3-A, 975 ft. S. of discovery well	14	1-11-60	dry	1,865
Reina Regente 1-A, discovery well	14	9-25-59	oil well	1,335
Reina Regente 1-AX, 35 ft. E. of discovery well	14	12-24-59	oil well	6,015
E. Cent. Visayan Basin, S. Cebu, Alegria Anticline				
Republic Resources & Dev. Corp. and Philippine Oil Dev. Co., Libron 1	15	9-10-60	dry, sog	6,125
Strat. 1 (Paque)	15	9-25-60	dry, so	274
Strat. 2 (Cardona)	15	9-25-60	dry	455
Strat. 3 (Tremper)	15	9-25-60	dry, so	673
Strat. 4 (P. Yong)	15	9-25-60	dry	100
Strat. 5 (Enad 1)	15	9-25-60	dry, so	410
Strat. 6 (Enad 1-A)	15	10-15-60	dry, so	440
Enad 1-B	15	11-15-60	dry, so	450
Bylosis 1	15	12-15-60	dry	1,023
E. Cent. Visayan Basin, Camotes Isl.				
White Eagle Overseas Co., Test Well 1	16	6- 7-60	dry	346
Test Well 2	16	5-24-60	dry	1,537
Test Well 3	16	6- 3-60	dry	1,811
Test Well 4	16	6-17-60	dry	1,826
Test Well 5	16	6-23-60	dry	1,506
E. Cent. Visayan Basin, N.W. Leyte				
White Eagle Overseas Co., Test Well 1	17	3- 2-60	dry, sg	1,505
Test Well 2	17	2-16-60	dry, sg	1,509
Test Well 3	17	4-24-60	dry, sog	1,510
Test Well 4	17	5-10-60	dry	1,805
Test Well 6	17	3-12-60	dry, sog	1,805
Test Well 7	17	3-18-60	dry, sog	1,485

Abbreviations—Dry hole: dry. Dry hole, with show of gas: dry, sg. Dry hole, with show of oil: dry, so. Dry hole, with show of oil and gas: dry, sog.

PHILIPPINES

wells and 72,828 feet of hole or 4,855 feet per well drilled in 1959. (Table 1.)

The 38 completions in 1960 included eight wells ranging from 5,000 to 10,000 feet deep, located on Luzon, Panay, and Cebu islands. The average depth per well for the Philippines was held down, however, by over one half dozen stratigraphic tests of less than 1,000 foot depth each, mostly on southern Cebu island. (Table 2.)

Heretofore, the search for petroleum in the Philippines has been retarded by the shortage of dollars and the resultant scarcity of proper equipment and qualified technicians. But now the government is relaxing restrictions on dollars, which will be more readily available henceforth for petroleum development.

Oil in central Cebu. Prior to the oil discovery by American-Asiatic in northern Cebu in the spring of 1961, crude oil production in the Philippines remained limited to that of Republic Resources and Development Corp. on central Cebu island. (WORLD OIL, Aug. 15, 1960, Pages 281 and 282.) Redeco's discovery well, Reina Regente 1-A, began experiencing pump trouble in mid-1960, and in early 1961 it was reported that a thief zone had stopped production. The well was drilled to 1,335 feet, and had a productive capacity of 72 barrels daily of 41-45 gravity crude. Reina Regente 1-A-X, 35 feet east of the discovery well, was reported last spring to be pumping three to seven barrels per day from a lower Miocene sand at 1,477-1,483 feet.

Redeco failed to develop additional production around its two oil wells in central Cebu, although a half dozen more wells were drilled. Those additional wells and the two oil wells are listed in Table 2.

Three wells were drilled in 1960 jointly by Acoje Oil Exploration Co. and Hixbar Mining Co. on the Barili anticline in Hixbar's central Cebu concession. Malolos 1 was plugged and abandoned in November, 1960, at 9,017 feet, after unsuccessfully testing oil shows in thin lower Miocene sands at 7,132-7,220 and 7,302-7,326 feet and several gas zones between 1,254 and 6,435 feet.

Malolos 2, one half mile southwest of No. 1, was abandoned in December 1960 at 2,009 feet. Shows of gas were found in upper Miocene limestone. Malolos 3 was abandoned in February 1961 due to bad hole conditions at 953 feet, and a new hole was started 200 feet away.

Acoje has two low volume shut in gas wells in northern Cebu, Libertad 11 and 13. (Table 2.) They were drilled in 1958 to 721 and 575 feet.

In September 1960, Republic Resources and Development Corp. abandoned Libron 1, a joint test with Philippine Oil Development, Inc., on the Alegria anticline in southern Cebu. The well bottomed in lower Miocene at 6,125 feet. Several gas shows and one oil sand were tested with negative results. Following the abandonment of this well, the two companies drilled eight shallow tests on the same structure, up to a maximum depth of 1,023 feet. Oil bearing Miocene sands were encountered in five of these tests, but attempts to complete the wells as producers failed.

Drilling on other islands. To the northeast of Cebu, White Eagle Overseas Oil Co., Inc., in the first half of 1960 drilled 11 stratigraphic tests to a

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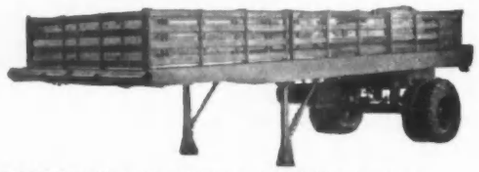

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maximum depth of 1,826 feet on concessions in Leyte and Camotes Islands. Oil and gas shows were reported in all six tests in Leyte, where White Eagle has a carried interest in holdings of Luzon Stevedoring Co.

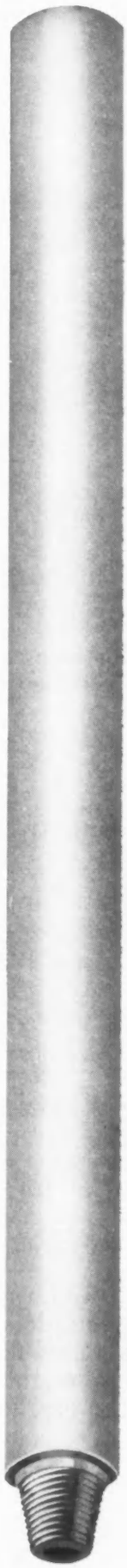
On northern Negros Island, adjoining Cebu on the west, Maremco Mineral Corp. drilled a 1,709 foot core hole, Fuentes 1, finding shows of gas. And Anglo Philippine Oil Corp.'s Sagay 1 was dry at 1,304 feet. On southern Negros, Anglo Philippine's Bagtic 1 and 2 were dry at 457 and 780 feet.

In the Iloilo Basin, Panay Island, northwest of Negros Island, Philippine Oil Development Co. (Podco) abandoned Tigbauan 1 at 7,485 feet after finding shows of gas, and also had gas shows in San Miguel 1, which was abandoned at 7,272 feet.

In southeastern Luzon, Philippine Oil Development Co. in December 1960 plugged and abandoned Bondoc 7 on the Molave-Maglihi anticline in lower Miocene shale at 4,262 feet after finding several gas shows. Also in southeastern Luzon, Philex Oil Development, Inc., is drilling stratigraphic tests jointly with Baguio Gold Mining Co. Their Santo Nino 1 was abandoned at 600 feet January 22, 1961, due to bad hole conditions. A number of oil and gas shows were reported in Santo Nino 1-A, which reached rig capacity of 1,500 feet in February 1961. A third test was planned.

Standard Vacuum Oil Co. (Standard of New Jersey and Socony) during 1960 drilled three unsuccessful wildcats in the Cagayan Valley Basin of northern Luzon. Rizal 1, Narra 1, and Paret 1 were abandoned at 9,236, 6,123, and 5,500 feet. Miocene limestone objectives in the first two wells were not reached because of mechanical difficulties and limited time before the rainy season. All objectives were penetrated in Paret 1, but the limestone and sand objectives were water bearing. In the southern part of this basin Stanvac made a gas well of Ipil 1 at 7,260 feet in July 1958.

Texaco Overseas Petroleum Co. and California Asiatic Oil Co. in January 1960 abandoned their northern Luzon wildcat, Illuru 1, as a dry hole at 10,243 feet. They previously had joined with Podco for the two 1956 and 1957 Tumaiuni tests in northern Luzon.



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TAP. 1

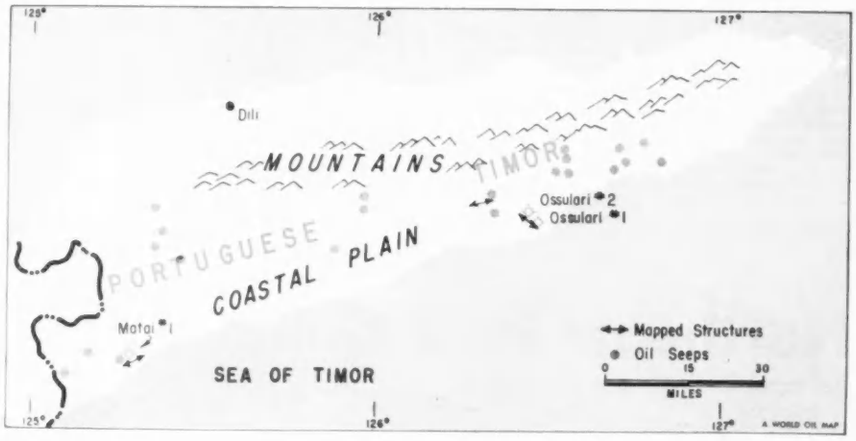
The natives quickly learn manual skills connected with drilling operations in Portuguese Timor.

Timor . . . new structure being tested

EXPLORATION PROCEEDED with some encouragement in 1960 and 1961, in Portuguese Timor, although it was impeded by mechanical difficulties and heavy rains. Timor Oil, Ltd., continued gravity work to augment previous core-drilling and geological coverage and had spudded Matai 1, located near the western edge of the south coastal plain by the end of 1960. By early 1961, this wildcat test had reached 2,037 feet.

Good oil shows were found at about 800 feet in an Eocene limestone. Some 37 degree API gravity paraffin base crude was recovered. A strong fresh water flow was struck at 1,800 feet and cemented off. It was planned to abandon Matai 1 and to commence a second test of the Matai structure close to the first one after midyear 1961.

Roughnecks include trained Australian (center) and native Timorese.



West New Guinea . . . production

further declines as depletion of fields continues

PRODUCTION of West New Guinea's three oil fields continued at a declining rate during 1960. Crude output was 1,543,289 barrels (see Table), an average of 4,217 bpd, down 333 barrels daily or 7.3 percent from the 1959 average of 4,550 bpd.

Klamono field, the shallowest one, located farthest west of the three on the Vogelkop Peninsula, yielded most of the production (3,816 bpd). Klamono field is located in the Salawati Basin, and Wasian and Mogoi fields are in the Bintoeni Basin east of the Ajamaroe plateau. Klamono's 1960 yield was down slightly from the 4,042 bpd rate of 1959; Wasian

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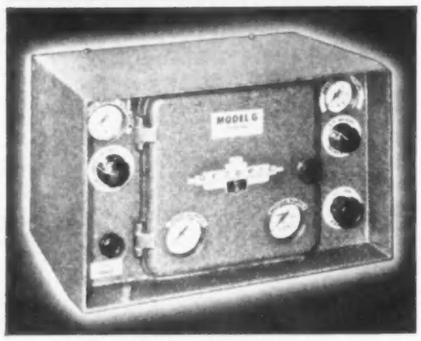

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WEST NEW GUINEA

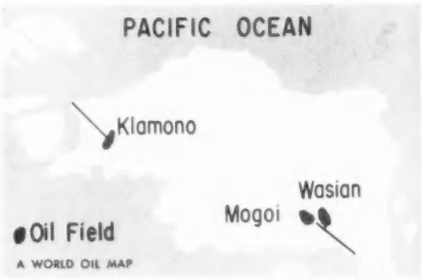
also dropped from 301 bpd in 1959 to 224 bpd in 1960, and Mogoi fell from 207 to 177 barrels daily in the same period.

Only about one-third of the wells drilled in these fields were on production at the end of 1960. Daily production last December was 3,547 bpd, portending continued depletion.

Drilling. The operator, Nederland Nieuw Guinee Petroleum Mij (NNGPM), composed of Royal Dutch Shell, Stanvac and Caltex interests on a 40-40-20 percentage basis respectively, drilled 5 oil wells in Klamono field involving 5,405 feet of hole and 3 dry wildcats aggregating 9,500 feet last year. Exploration in the eastern part of the country had ceased by the start of 1960. No wells were being drilled at the end of December.

The breakup of Stanvac does not significantly alter the setup in West New Guinea. Mobil Petroleum Co., Inc. and Esso Standard Eastern, Inc. will continue to share Stanvac's exploration interests in New Guinea on a 50-50 basis.

Oil Fields of the Vogelkop (Bird's Head) Peninsula, W. New Guinea



Production and Drilling in West New Guinea in 1960, by Fields

All development is by one company, N. V. Nederland Nieuw Guinee Petroleum Mij (NNGPM).

ITEM	Klamono	Wasian	Mogoi	Total
Year of discovery	1936	1940	1940	
Development footage drilling in 1960	5,405			5,405
Oil wells drilled in 1960	5			5
Total wells drilled to end of 1960	46	23	56	125
Total producing wells at end of 1960	27	6	10	43
Flowing wells		1		1
Pumping wells	27	5	10	42
Producing depths in feet	300	2,900-3,225	1,250	
Gross barrels clean crude production in 1960	1,396,628	81,778	64,883	1,543,289
Daily average production in Dec. 1960, bbls.	3,252	167	128	3,547
Cumulative production to end of 1960, barrels	20,297,783	1,693,277	4,330,652	26,321,712
Base of crude	Asphaltic	Paraffinic	Paraffinic	
API gravity of crude	18.8°	41.9°	42.8°	
Age of producing formation	Miocene	Miocene	Miocene	
Type of producing formation	limestone	limestone	limestone	
Structure of controlling production	Anticline	Anticline	Anticline	

Northeast New Guinea . . . oil to be sought on north coast

THERE IS SOME interest in oil possibilities in Northeast New Guinea (Territory of New Guinea), now under Australian mandate. A prospective Tertiary section with complex structural features occurs in this remote area which has been checked by several oil companies. It is a jungle and mountain country peopled largely by Stone Age aborigines.

Northeast New Guinea was placed under League of Nations trusteeship when the old German empire was dismembered following World War I. Hence it has a slightly different political status than Papua to the south, although Australia governs both regions.

Reportedly, Enterprise of New Guinea Gold and Petroleum N. L. was seeking additional capital last year to validate its conditional oil search permit covering about 100 miles of the north coast from the Wewak vicinity to the West New Guinea border. This 3,600-square-mile area was said to cover a sedimentary basin between the coast and the east-west running Torricelli and Bewani mountain ranges. The permit was conditioned upon proof of financial competence and upon provision of stipulated aerial photographic and surface geological survey coverage.

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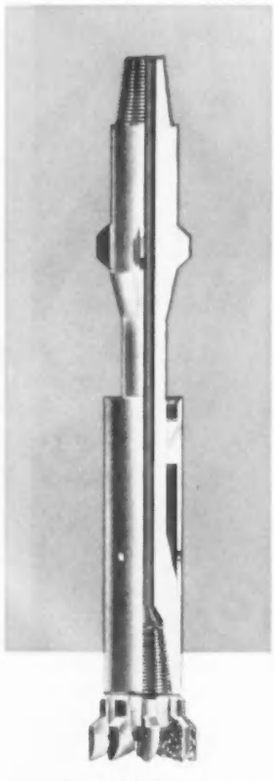

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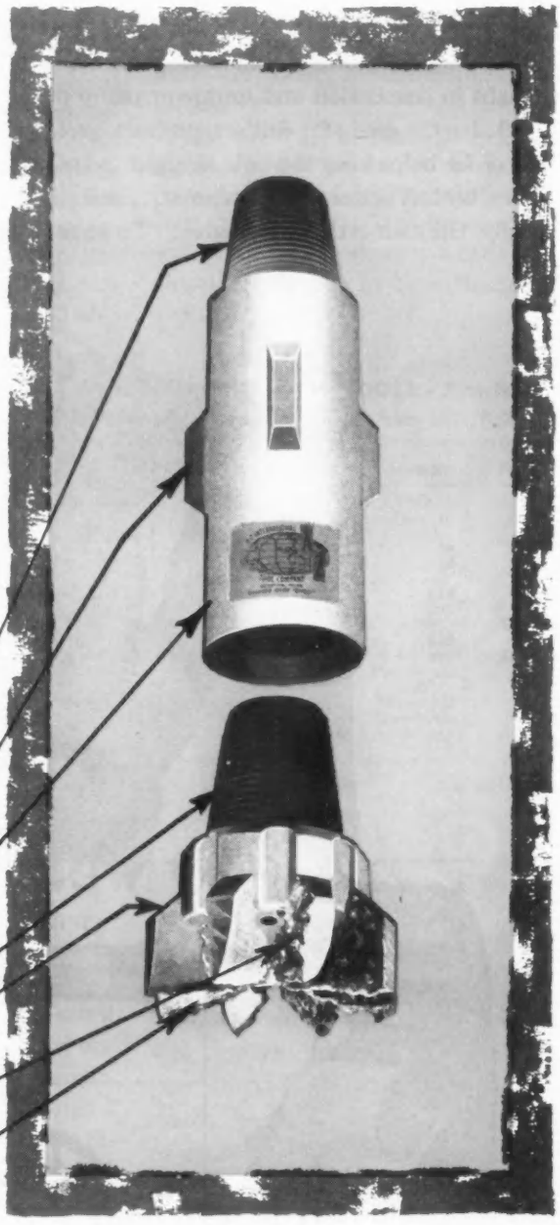
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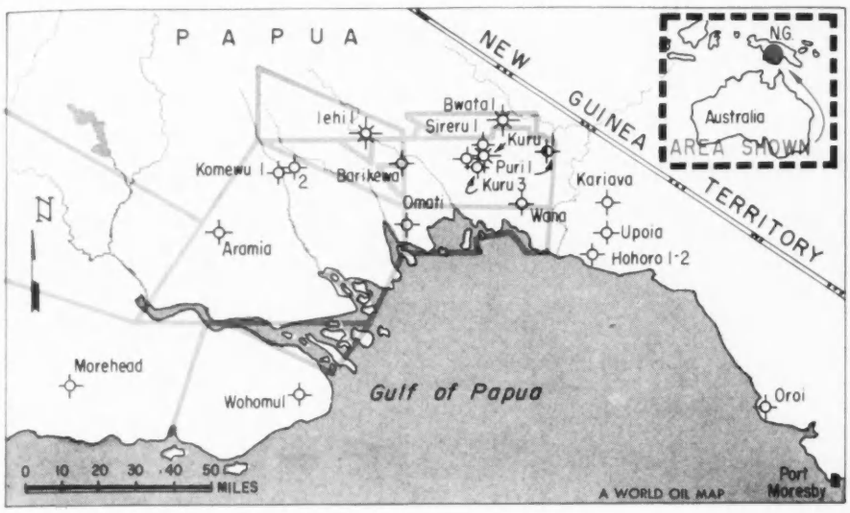
CONCESSIONS AND DRILLING ACTIVITY IN PAPUA

(An Australian territory on the island of New Guinea)



Papua . . . recent discoveries indicate gas reserves, but no oil found

SIGNIFICANT GAS RESERVES are indicated in two recent discoveries in Papua, remote from any gas markets foreseen at present. No significant oil reserves had been proven as of the spring of 1961, and the major companies which had financed much of the Papuan exploration to date have largely withdrawn from the venture. A new development was an offshore oil exploration survey under way early in 1961.

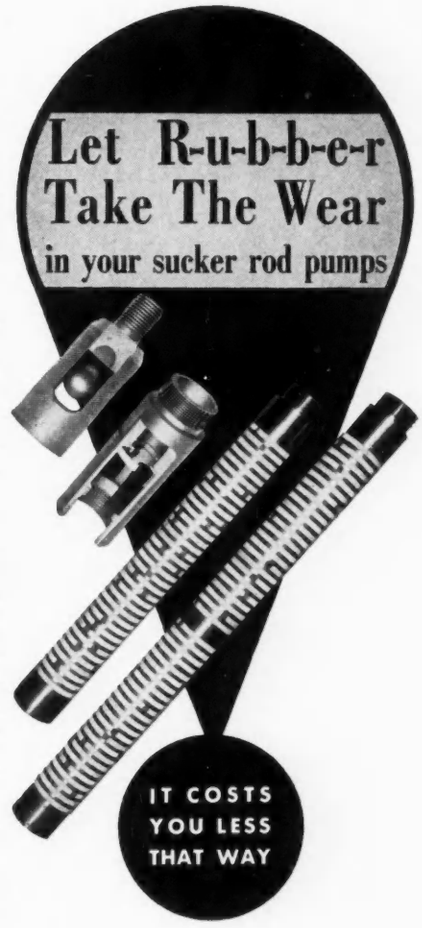
The Bwata gas discovery was completed early in 1960 by Australasian Petroleum Co. 15 miles northwest of Puri. At Puri, a 1,000-bpd oil well was tested early in 1959 only to go to 100 percent salt water in a few days. Bwata 1 was completed at 7,302 feet on January 8, 1960. A Tertiary limestone at 4,750 feet was acidized, and tested more than 20 million cubic feet of gas daily. Gas-condensate ratio reportedly exceeded 200,000. The Bwata well is now abandoned.

The same company then drilled Iehi 1 on a structure located 15 miles northwest of Barikewa, with the participation of BP Exploration Co. and Oil Search Ltd. but without the third partner involved in the Papuan venture, Vacuum Oil Pty. Ltd. Iehi 1 was spudded in June 1960 and reached total depth of 10,042 in November. Flows of dry gas exceeding 30 MMcfd were reported from sandstone at about 4,710 feet, but the well has now been reported plugged also.

Marine seismic work along the Papuan coast from Port Moresby westward toward the West New Guinea border was begun in the spring of 1961. The exploration permit was held by Camelot Nominees Pty. Ltd. Partners reported in the venture are Murphy Corp., Burmah Oil Co., and certain Australian interests.

Oil Search Ltd. has agreed in principle to take over management, direction and control of Australasian Petroleum and Island Exploration Co., to continue the Papuan venture and to increase its holdings in both companies from 15 to 80 percent. Vacuum and BP each retain 10 percent.

Pursuant to the agreement between Standard Oil Co. (New Jersey) and Socony Mobil Oil Co. the former acquires the right to receive a half interest in Papuan ventures now participated in by Vacuum (Socony interests).



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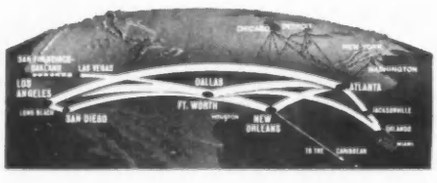

SEDIMENTARY BASINS AND OIL AND GAS OCCURRENCES IN AUSTRALIA AND NEW GUINEA

Australia . . . flowing oil well and two good gas wells in Queensland encourage exploration

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TABLE 1—Exploration Activity in Australia in 1960

STATE or TERRITORY	Nature of Survey and Duration in Party Months				
	Seismic	Gravity	Magnetic	Geological	Air-Photo
Queensland	45.59	4.55	6.07	26.25	....
New South Wales	3.19	3.61	0.54	44.41	....
Victoria	13.11	....	0.54	10.00	....
South Australia	16.11	9.75	2.00	17.96	....
Western Australia	7.92	4.50	0.50	15.10	....
Tasmania	....	....	....	....	....
Northern Territory	6.15	6.71	0.50	22.10	....
Papua-New Guinea	0.18	....	....	8.05	....
Total, 1960	98.32	29.12	10.15	143.87	....
Total, 1959	41.55	62.45	9.00	223.75	....
Total, 1958	56.75	29.00	5.50	139.25	....

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with the aid of subsidies from the Australian government. All work has been encouraged by oil and gas showings in various wells, the completion of two good gas wells in 1960 in the

TABLE 2—Summary of Drilling in Australia in 1960

STATE	Wells Completed During Year: Wells	Wells Completed During Year: *Footage	Wells Drilling: Yr. End	Wells Drilling: Mid-1961
Queensland	10	45,661	2	3
South Australia				1
Victoria	2	6,521		1
New South Wales	2	3,626	2	2
Western Australia	5	21,393		
Northern Territory	2	3,831		
Papua-New Guinea	1	10,042		
Total, 1960	†22	91,074	4	7
Total, 1959	53	119,010	6	

* Combined total depths of wells completed druing year.
† Includes 2 gas wells in Roma area, Queensland, and 20 dry holes, of which some had oil or gas showings.

TABLE 3—Petroleum Consumption and Refining in Australia
(Barrels Daily)

ITEM	1960	1959	% Up
Consumption	228,502	205,867	11.0
Imports of products	26,712	32,620	—18.1
Imports of crude oil	229,500	202,533	13.3
Refining capacity, Dec. 31	246,003	235,000	4.7
Average runs	228,770	203,856	12.2
Number of refineries in operation	7	7	...

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Horne Well Service Co.....3-5396
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Davis-Kemp Tool Co., Inc.....5541
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TABLE 4—Wells Drilled in Australia in 1960 and Early 1961

STATE, Basin, Company, Well, Location, and Remarks	Mo.-Yr. Completed	Results or Status	Depth in Feet
WESTERN AUSTRALIA			
Canning Basin—			
West Australian Pet. Co., Thangoo 1-A, se of Broome, oil traces in Ordovician shale	2—60	Dry, show oil	5,429
Barlee 1, ne of Broome	7—60	Dry	8,101
Rough Range Area—			
West Australian Pet. Co., Rough Range (?), further drilling contemplated	.....	Location	....
Perth Basin—			
Bureau of Mineral Resources, Beagle Ridge 1-A (BMR 10-A), 200 mi n of Perth, oil traces in Permian at 3,710 ft.	7—60	Dry, show oil	4,862
Beagle Ridge 2 (?), more drilling planned	.....	Location	....
Eucla Basin—			
Exoil Pty. Ltd., Eyre 1, stratigraphic test	1—60	Dry	1,719
Gambanga 1, strat. test	3—60	Dry	1,282
SOUTH AUSTRALIA			
Penola Trough—			
Oil Development N.L., Penola 1, 4 mi from Penola, reached 4,985 ft. drill pipe stuck, abandoned in May 1961; had gas shows around 4,600 ft.	5—61	Dry, show gas	4,985
General Exploration of Australia, Beachport 1, in spring 1961 well was scheduled	.....	Location	....
VICTORIA			
Otway Basin—			
Frome-Broken Hill Pty. Ltd., Port Campbell 2, tested salt water with gas	2—61	Dry, show gas	8,846
Port Campbell 3, 4½ mi nw No. 2, tested gas in sand at 4,956—4,963 ft; 5½" cas at 5,080 ft, td 5,530 ft; well testing in March 1961	.....	Testing	5,530
Gippsland Basin—			
Australian Paper Manufacturers Development Pty. Ltd., Rosedale 1	5—60	Dry	5,836
Murray Basin—			
Tallageria 1, sw corner PEP 17	10—60	Dry	685
NEW SOUTH WALES			
Sydney Basin—			
Australian Oil and Gas Corp. Ltd., Camden 11, sw of Sydney, gas at 1,646 and 1,753 ft.	4—60	Dry, show gas	2,029
Baulkham Hills 1, drilling in early April 1961 at 3,175 ft; had small gas shows at 2,900, 2,990, 3,117, 3,125, 3,173 ft.	.....	Drilling	3,037
Australian Iron & Steel Ltd., Cordell Park 1, small gas shows at 1,340 and 1,420 ft.	2—60	Dry, show gas	1,597
John Strevens Enterprises, Ltd., Terrigal 1, had oil shows, drilling in late 1960 at 1,590 ft.	.....	Drilling	1,590
Clarence River Basin—			
Clarence River Basin Oil Co., Clifden Dome 2, drilling in May 1961 at 577 ft; had gas shows at 509, 546, 570 and 576 ft.	...	Drilling	577
QUEENSLAND			
Condamine Oil Ltd., Speculation 1, suspended in late 1960 at 2,333 ft.	.....	Suspended	2,333
Bowen Syncline—			
Assoc. Freney-AAO-Papuan Apinaipi, Cooroorah 1, se of Roma	1—60	Dry	3,523
Great Artesian Basin—			
Delhi-Frome-Santos, Betoota 1, n of Innamincka	4—60	Dry	9,824
L. H. Smart Oil Exploration Ltd., Harkaway Scout 1	12—60	Dry	1,850
Orient Scout 1, Suspended in late 1960 at 1,658 ft.	.....	Suspended	1,658
Conorada Petroleum Corp., Ooroonoo 1, sw of Longreach, strat. test	8—60	Dry	3,852
Magellan Petroleum, Corfield 1, completed as water well.	6—60	Water well	4,507
AAO-Freney-Papuan Apanaipi, Timbury Hills 2, 3 mi. e of Roma, td 4,400 ft; comp. as gas well, 1¼ million cu. ft. daily, ¾ inch choke, from 3,700-3,733 ft.	4—60	Gas well	4,400
Pickanjinnie 1, 23 mi e of Roma; td 5,213 ft., flowed 6½ million cu. ft. daily, 1 inch choke, from 4,007-4,025 and 4,041-4,051 ft.	7—60	Gas well	5,213
Pickanjinnie 2, one mi from No. 1; plugged; had oil and gas shows in Timbury Hills formation	2—61	Dry, show oil	5,591
Latemore 1, e of Roma and w of Pickanjinnie 1, td 4,775 ft., tested 60,000 cu. ft. gas daily at 4,229-4,449 ft.	8—60	Dry, show gas	4,775
Latemore East 1, e of Roma, td 4,724 ft., tested 200,000 cubic ft. gas daily at 4,204-4,340 ft.	10—60	Dry, show gas	4,724
Combarngo 1, 30 mi se of Roma, at Combarngo, 17 mi s-se of Pickanjinnie, drilling in May 1961; reported to have yielded non-commercial quantities of high gravity oil; on structure outlined by seismograph; well is 70 mi nw of Union Oil's Cabawin 1, oil well	.....	Drilling	....
Phillips-Sunray, Quilpie 1, 20 mi n, 5 mi w of Quilpie, 10,000 ft test of buried Paleozoic anticline; was scheduled to be spudded in April 1961	.....	Drilling	....
Surat Sub-Basin of Great Artesian Basin—			
Union Oil-Kern-AOG, Cabawin 1, se of Roma and Surat and sw of Tara, td 12,035 ft., in June 1961 was flowing 60 bbls daily of 48-51 gravity oil through choke from Permian sand at 9,925-10,172 ft.	4—61	Oil well	12,035
Ipswich Basin—			
Queensland American Oil Co., Overflow 1, 12 mi nw Beaudesert	5—60	Dry	2,993
Standard Gas Pty. Ltd., Cribb Island 1, n of Brisbane, drilling in late 1960 below 1,420 ft.	.....	Drilling	1,420
Aspley Scout 1, suspended in late 1960 at 970 ft.	.....	Suspended	970
Gulf of Carpentaria—			
Delhi Australian and Santos Ltd., Mornington Island 1, stratigraphic test of Mornington Island structure, in Gulf of Carpentaria, plugged and abandoned at 2,764 ft. in early June 1961 after encountering granite	6—61	Dry	2,764
Mornington, Island 2, 20 mi e-ne of No. 1, plugged and abandoned in early July 1961 after encountering basement rocks at 3,000 ft.	7—61	Dry	3,000
NORTHERN TERRITORY			
Bonaparte Basin—			
Oil Development, Spirit Hill 1, commenced by Westralian Oil Ltd., in 1959	11—60	Dry	3,003
Spirit Hill 1-A, deepening or relocating of Spirit Hill 1 contemplated, to test Devonian	.....	Location	....
Bathurst Island 1, n of Darwin and ne of Spirit Hill development	12—60	Dry	828
PAPUA (NEW GUINEA)			
Australasian Pet. Co. Pty. Ltd., Iehi 1, had oil sands	12—60	Dry, show oil	10,042

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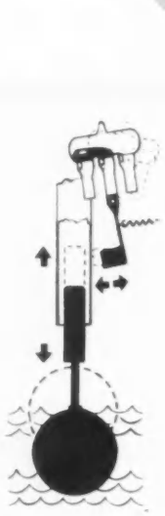

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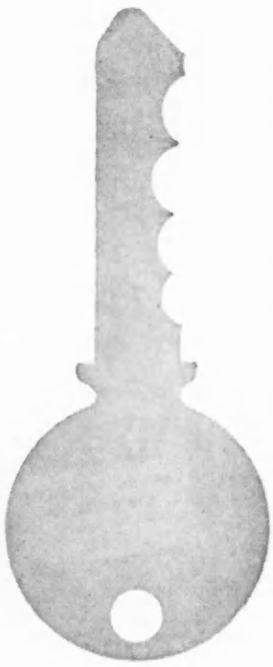

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Roma area, Queensland, and the sustained flowing oil production in 1961 from Union Oil Company's well, Cabawin 1, southeast of Roma and southwest of Tara, Queensland.

There has been considerable activity in the search for oil and gas in the first half of 1961. A number of geophysical surveys and drilling operations have been undertaken in all states and territories except Tasmania. Development has been especially active in Queensland, as a result of the gas and oil discoveries in 1960 and 1961. Several wells are drilling ahead in various states, and a number of other wells are scheduled to be spudded in the near future.

Subsidies. The Commonwealth Petroleum Search Subsidy Act 1959 has provided a strong impetus to oil exploration. Up to June 30, 1961, the Commonwealth has subsidized or is committed to subsidize 32 drilling operations (stratigraphic and off-structure drilling), and 61 geophysical operations (seismic, gravity, and aeromagnetic surveys) and bore-hole surveys, to the extent of more than 4 million Australian pounds.

The promising indications of oil in Australia and the favorable political and economic stability of the Commonwealth have encouraged considerable overseas interest, not only in the technical aspects of the oil search but also from the investment viewpoint. This interest has been reflected in the increased expenditures on oil search in 1960 and 1961 by private companies.

Oil exploration activities of Commonwealth and State agencies also have increased substantially.

Discoveries. In the Roma district of southeastern Queensland, in the eastern portion of the Great Artesian Basin, high gravity oil has been found in 1961 in non-commercial quantities in two wells: (1) Cabawin 1 of Union Oil Development Corp. (a subsidiary of Union Oil Co. of California), Kern County Land Co., and Australian Oil and Gas Corp. Ltd., and (2) Combarngo 1 of Associated Australian Oilfields N. L., Associated Freney Oil Fields N. L., and the Papuan Apinaipi Petroleum Co. Ltd. Also in the Roma area, the latter group in 1960 completed two good gas wells, Timbury Hills 2 and Pickanjinnie 1, and encountered smaller volumes of gas in two other wells.

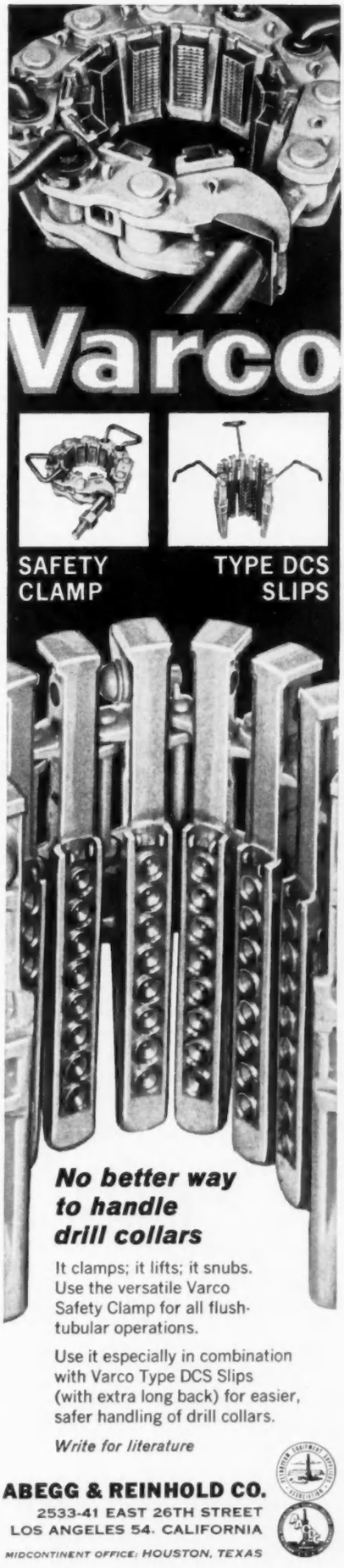
Cabawin 1. As of the first week of June 1961, Cabawin 1 of Union Oil and associates had been on sustained production for three weeks, flowing an average of 60 barrels daily of 48-51 gravity oil through chokes from the interval 9,925-10,172 feet in Permian sandstone. Shut in pressure tests were being conducted. Before the well could be fully evaluated, the company said, several other possible productive intervals would have to be tested.

Seismic work was continuing to determine the best location for a second exploratory well.

Cabawin 1 was drilled to a total depth of 12,035 feet. During initial tests made in April and May 1961, it produced as much as 85 barrels per day through a 24/64 inch choke, with gas-oil ratio of 7,420. (World Oil, June 1961, Page 143.) Depending upon flow rates, casing pressures have ranged from 350 to as high as 1,700 pounds per square inch.

Roma gas field. Following seismic work in 1959, Associated Australian Oilfields N. L. and associates in 1960 and 1961 have drilled several wells east of Roma and encountered gas in varying volumes in the Permian around 4,000 feet. Timbury Hills 2, three miles east of Roma, in April 1960 produced petroliferous gas at the rate of 1½ million cubic feet per day through a ¼ inch choke from the Timbury Hills formation at 3,700-3,733 feet. The well now supplies gas as fuel for generating electric power at Roma. Pickanjinnie 1, about 20 miles east of Timbury Hills 2, in July 1960 penetrated four gas sands in the Permian section, and the top two at 4,007-4,025 and 4,041-4,051 feet yielded a steady flow of over 6½ million cubic feet of gas per day through a 1-inch choke. (World Oil, April 1961, Page 101.)

Gas was first discovered at Roma early in this century. From 1928 to 1932 oil was produced from a gas absorption plant and was sold locally at Roma. Significant but non-com-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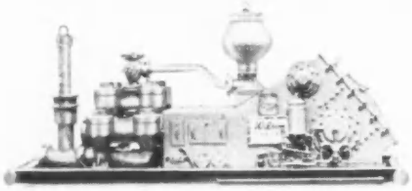

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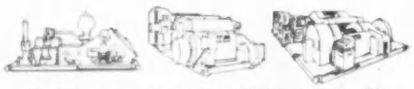

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AUSTRALIA

mercial quantities of oil have been recovered from some wells.

In Western Australia the WAPET group (Caltex and Ampol) in 1953 struck the first potentially commercial oil in Australia. A well in the Rough Range area flowed 1,680 barrels per day of heavy, paraffinic crude through a ¾ inch choke from thin basal Cretaceous (Birdsong) sands at 3,600 feet. But unproductive offset tests indicated a pool of less than 50 acres. The company moved operations into the Kimberleys to the northeast. Several wells there had showings, and small amounts of oil were produced at Meda. The company only now is returning to the Rough Range area, where it contemplates further drilling.

A complete report on all drilling in Australia in 1960 and early 1961 is presented in Table 4 (Page 246).

New Zealand . . . second deep well on west coast of North Island yields gas on tests

DEEP DRILLING is being continued in New Zealand by the group including British Petroleum Company, Shell and Todd Oil Services, Ltd. A second deep test was being drilled at midyear 1961 in the coastal area on the west side of North Island, in Taranaki province. Burning gas flared into the night sky at mid-June 1961 at the site of Mangahewa 1, eight miles south of Waitara and near Tarata.

An analysis of the gas was being made. The gas flowed at a pressure of 3,400 pounds per square inch in a second stage of testing of the well at the 13,000 foot horizon, with the bottom of the hole at 14,000 feet. The well previously had flowed gas also in a first stage of testing at the 14,000 foot level.

Plans for drilling Mangahewa 1 were finalized at midyear 1960. Drilling of Mangahewa 1 commenced in late 1960, after assembly of a rig with greater capacity than that used on Kapuni 1, the first wildcat of the group in the area. Located 11 miles from Hawera, Kapuni 1 was drilled in 1959 to a depth of 13,040 feet. It gave an encouraging show of "wet" gas, which justified an extension of exploration activities.

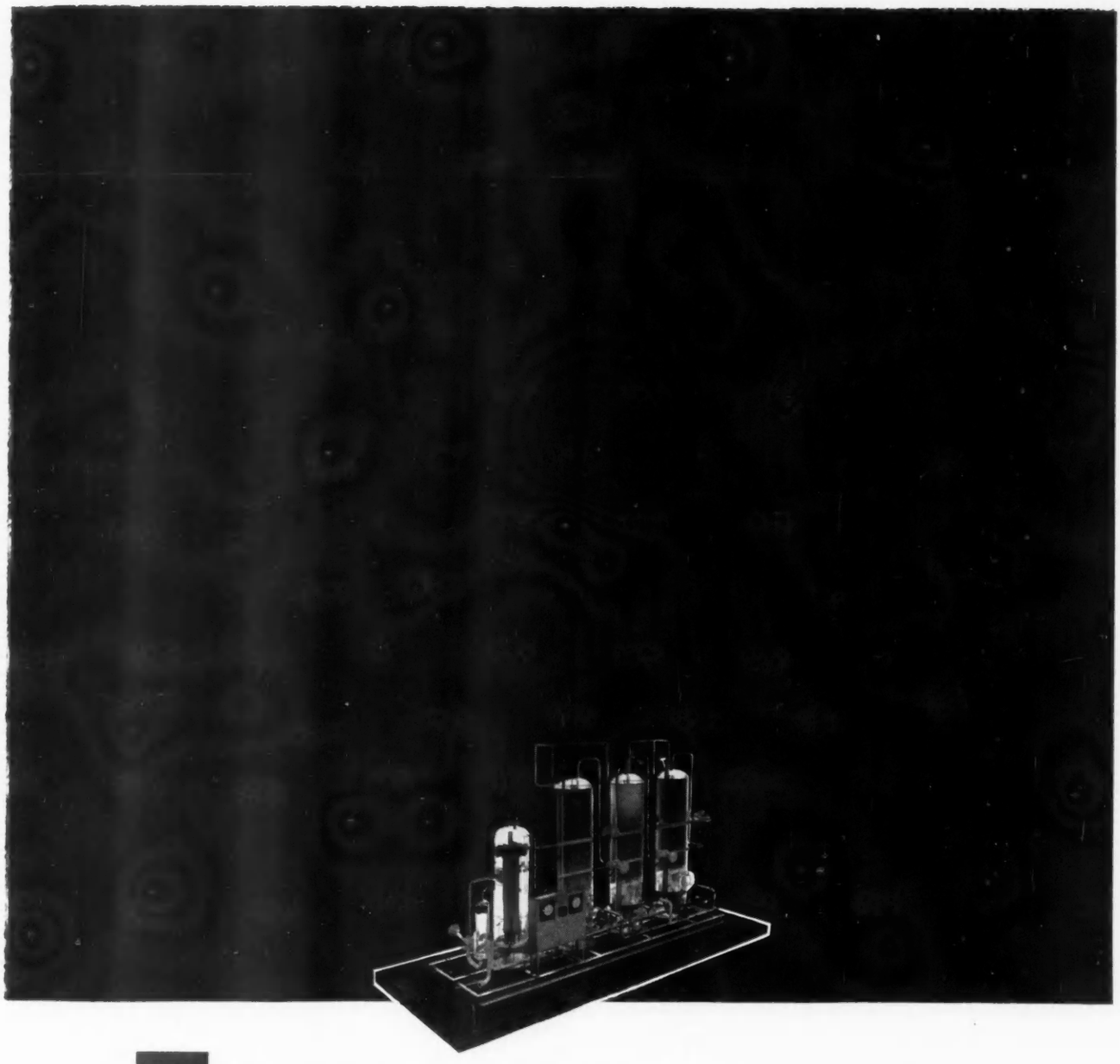
East Coast. The rig used on Kapuni 1 was moved at midyear 1960 to the site of Mangaone 1, southwest of Gisborne, on the east coast of North Island. The location was a few miles from Nuhaka in Hawkes Bay. It was expected that a depth of about 12,000 feet would be reached. But eventually, after 10 months of drilling and encountering innumerable difficulties, Mangaone 1 was stopped at 5,085 feet, as it was uneconomic to proceed further.

At the middle of 1961 additional exploration sites were under preparation in both the west and east coast areas of the North Island.

In addition to its search for oil in New Zealand in partnership with others, British Petroleum Company has been exploring on its own in the Marlborough province of South Island since 1958, and has carried out considerable geological work there.

Production. Crude oil production in New Zealand is limited to that of Edgmont Oil Wells, Ltd., of New Plymouth. It has been totaling approximately 4,500 barrels per year. Averaging about 12 barrels daily, the production has been coming from four wells, indicating output of about 3 barrels daily per well. In addition, about 5½ million cubic feet of natural gas per year is produced. It is supplied to the New Plymouth gas works.

Refinery planned. Construction of New Zealand's first oil refinery at Marsden Point, Whangarei, with an initial capacity of about 50,000 barrels a day, may begin by the end of this year, and the plant should come on stream early in 1964. When completed it is expected to supply about 90 percent of New Zealand's oil requirements. The refinery will be operated by New Zealand Refining Company, Ltd., which will be owned by the general public and the oil companies that distribute petroleum products in New Zealand, including BP with a 15 percent share.



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186	187	189	191	192	193	194	195	196	197	199	200	201	202a	202b	203	204	205	206	207
208	209	210	211	212	213	214—215		216	217a	217b	218	219	220	222	225	227	228a	228b	228c
228d	229	231	234	235	236a	236b	237	238	239	240	241	242	243	244	245	246	247	248a	248b
248c	249	250	251	255	256														

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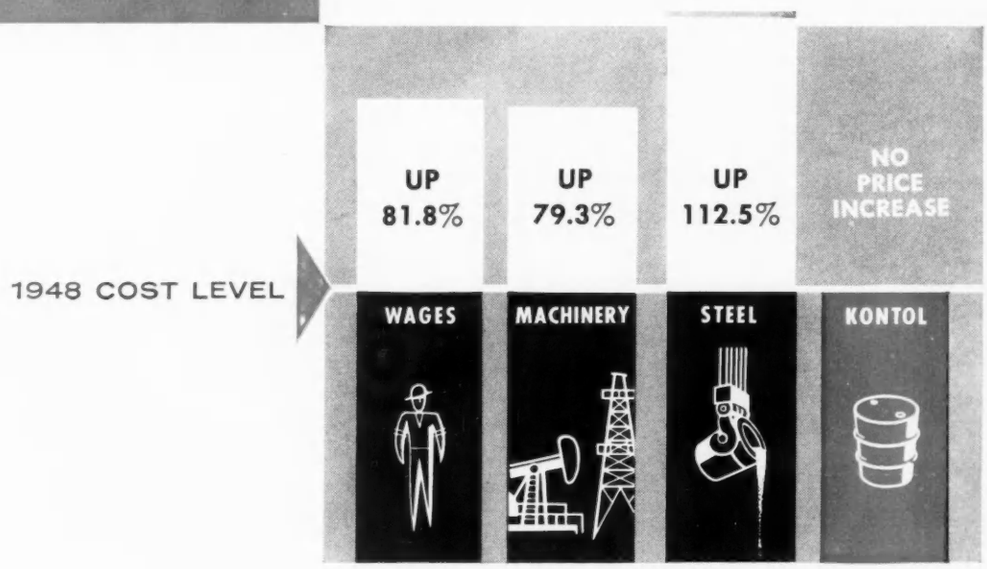
TRETOLITE SERVICE report

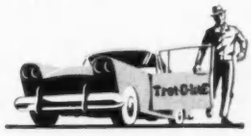


IN A PERIOD OF RISING PRODUCTION COSTS

KONTOL *prices are still at 1948 level!*

The Tretolite research staff constantly seeks ways to produce better KONTOL* Corrosion Inhibitor formulas for less money. This concern for *cost control* as well as *corrosion control* has kept the per gallon price of KONTOL at the 1948 level! Today, when costs of equipment, material, and wages are spiraling higher, it makes more sense than ever before to invest in a sound KONTOL corrosion control program.

Ask the Man in the Red Car how it can be done.



*Registered trademark, Petrolite Corporation

PETROLITE CORPORATION

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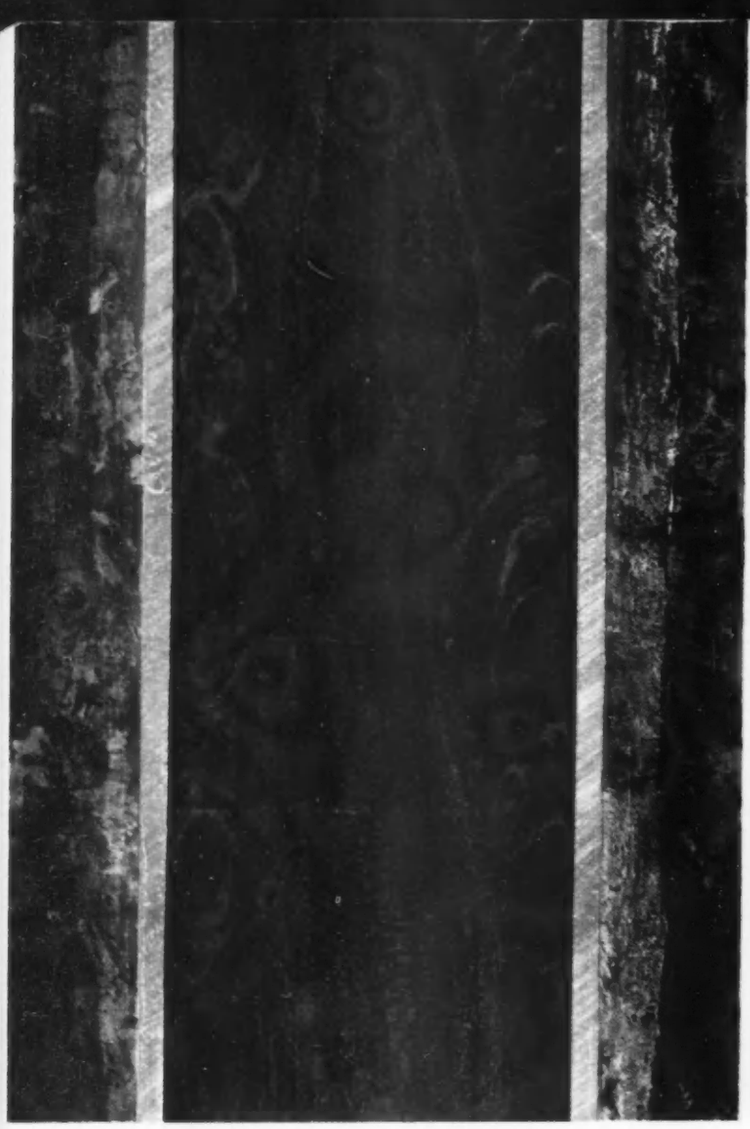
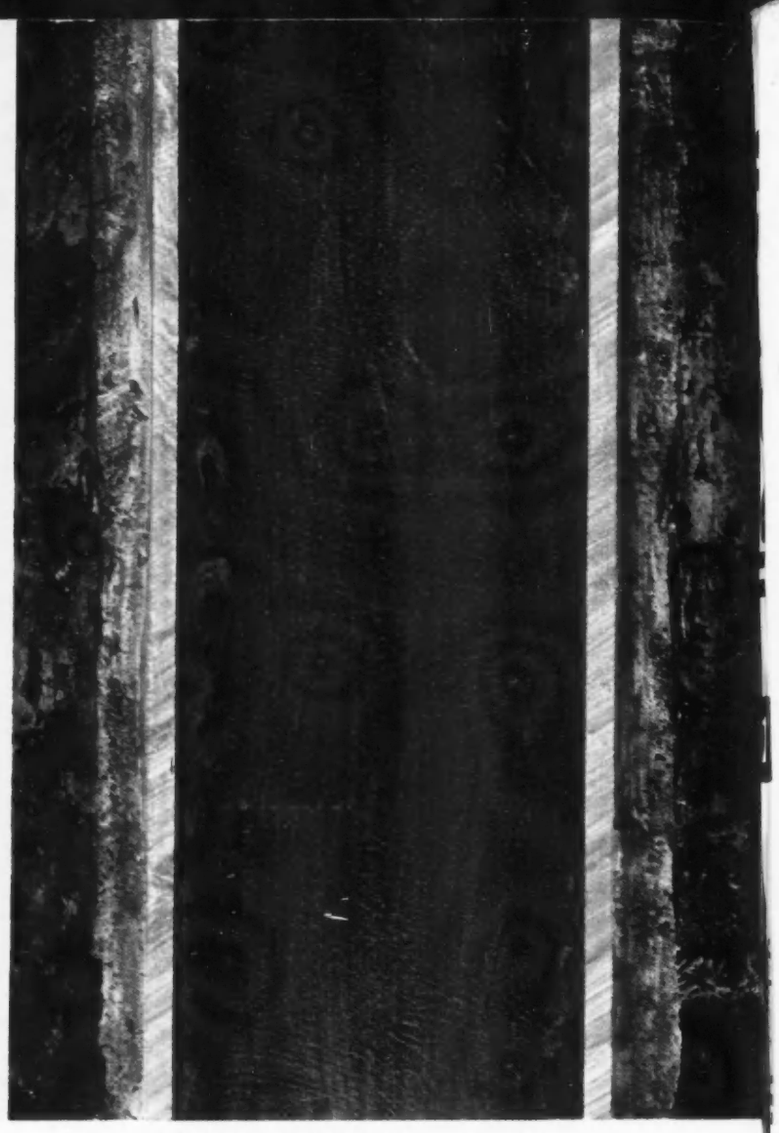


LOOK AT THE TURBULENCE in casing or tubing during a well stimulation treatment. Until recently, much of the available pumping horsepower was spent just to overcome this turbulence.



TURBULENCE IS SUPPRESSED when Slick Water or Slick Oil is added to the treating fluid. Injection rates may be more than doubled or required horsepower may be cut by as much as 70 per cent.

how Dowell's new friction-reducing agents help increase profits from fracturing and acidizing

These cross-section illustrations, as visualized by an engineer, show fluid flow down casing or tubing during fracturing or acidizing. They show how extreme turbulence wastes pump horsepower; much of the available horsepower must be used to fight this turbulence.

Slick Water* and Slick Oil* – the Dowell-developed friction-reducing agents for water, acid and oil – have made it possible to more than double the injection rate with the same horsepower. In other cases, a given injection rate has been achieved with only one pump instead of three. In still other cases, these agents have saved the cost of pulling tubing. High-injection-rate treatments have been performed down strings of 2⅞-inch casing in multiple tubingless completions. Slick Water and Slick Oil have made large fracturing treatments economical for some marginal wells by permitting the use of lower-cost fluids. They have helped many operators get exceptional production increases per dollar invested.

Ask your Dowell representative how these new friction-reducing agents can help you increase profits from well stimulation. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

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